ALPHA CEMENT

HOW TO USE IT

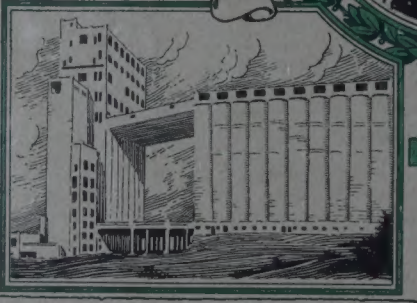
A PRACTICAL HANDBOOK
ON CEMENT BUILDINGS
AND IMPROVEMENTS

Built with ALPHA CEMENT

EXAMPLES of LARGE BUILDINGS & GREAT ENGINEERING UNDERTAKINGS IN WHICH ALPHA CEMENT WAS USED AFTER MEETING SEVERE TESTS FOR HIGH QUALITY

The Chicago Civic Opera Building, Chicago

The New York Aqueduct



Missouri Pacific Elevator, St. Louis, Mo. 2,000,000 Bu. Grain Elevator

Cahaba River Road Jefferson County, Alabama

Merchandise Mart, Chicago

ALPHA CEMENT

HOW TO USE IT

A Practical Handbook

ALPHA PORTLAND CEMENT COMPANY

BIRMINGHAM, ALA. *Webb Crawford Building*
BOSTON, MASS. *Board of Trade Building*
CHICAGO, ILL. *165 W. Wacker Drive*
EASTON, PA. *15 S. Third Street*
IRONTON, OHIO *Third and Center Sts.*
NEW YORK, N. Y. *230 Park Avenue*
PHILADELPHIA, PA. *Harrison Building*
PITTSBURGH, PA. *Oliver Building*
ST. LOUIS, MO. *1233 Arcade Building*

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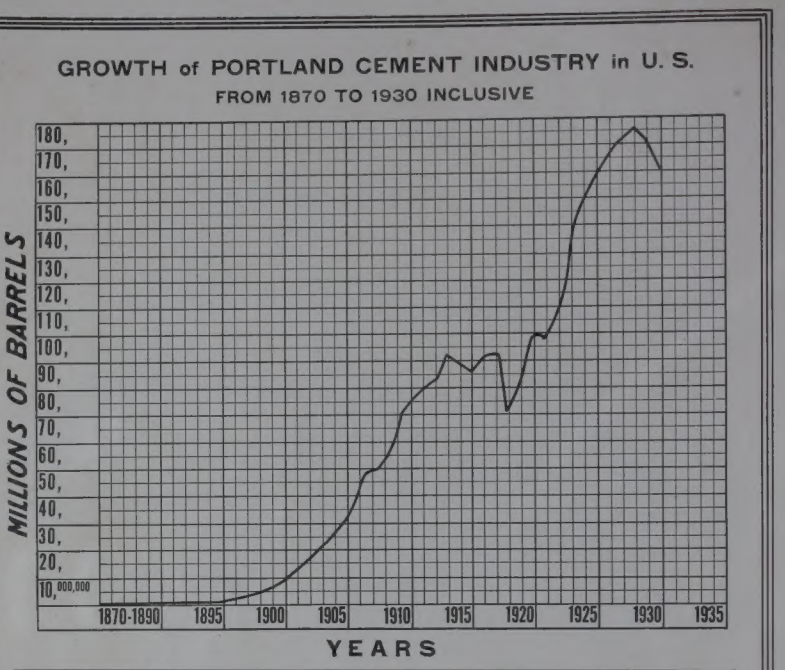

Growth of Portland Cement in America

A LITTLE over fifty years ago the first two Portland Cement plants in the United States were established. Today there are about one hundred and sixty-five plants in active operation. Cement as an essential commodity is now in the front rank of domestic manufacture.

The chart above, showing the production of Portland Cement in America, indicates that cement manufacture has attained an important position in our industrial life. From 1872 to 1878 the average annual production was 9,000 barrels, and by 1902 it had increased to 17,230,644. By the end of 1928, as shown in the chart, the production had leaped to over 176,000,000 barrels while in the following two years, due to the recession in business, production of cement dropped to 161,197,228 barrels in 1930.

Cement is one of the few materials not destroyed when it is used. Mankind, by endeavoring to create comfort, safety, sanitation, beauty and permanence, naturally seeks the use of Portland Cement, and the growth of that material will continue to go on year after year.

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Cement Construction and Portland Cement

THE WORD "CONCRETE" refers to sand, pebbles, gravel or crushed stone or other hard material such as slag, hard cinder, etc., which has been thoroughly mixed with Portland Cement and water and allowed to harden.

Portland Cement is the most tenacious binding material or mortar known. When properly mixed with the other materials named, it binds with a grip that makes the entire mass as hard and imperishable as if it were cut from solid stone. This "manufactured stone" has rapidly become the principal building material, where strength, durability, and protection against fire, water, rats, etc., are essential.

As concrete requires, in addition to cement, only the most commonplace and easily procured materials—sand, stone, and water—and is simply made, being merely mixed thoroughly, cast in place, and allowed to remain in forms until the hardening takes place, cement construction has a wonderful growth. Its earliest general use was in great engineering undertakings—bridges, retaining walls, sea walls, and the like, but now that the advantages of cement work have become universally recognized, a great list of buildings and improvements, ranging from such small constructions as fence posts to the largest factories and warehouses, are being everywhere built "the permanent way."

Why Cement is Called "Portland"

"Portland" is merely a generic name, such as "wrought" as applied to iron, or "Russia" or "sole" as applied to leather. The name was applied to this class of cement because, when Joseph Aspdin, of Leeds, England, discovered in 1824 the method of making the cement, the product had a "fancied though really slight resemblance to the noted oolitic limestone from the Isle of Portland, on the South coast of England." That oolitic limestone, which by the way is used in the London Westminster Cathedral, was known as "Portland Stone"; hence it seemed natural to give the name "Portland Cement" to the new product that made stone resembling Portland Stone.

There are now almost as many different brands of Portland cement as there are brands of flour or lime.

Increase in Use of Portland Cement

Some idea of the widespread increase in the use of Portland Cement may be gained from the fact that 8,482,000 barrels were manufactured in America in 1900, while the present yearly output is over 170,000,000 barrels. The United States at present leads all other countries in production, and cement is produced at many different points—with raw materials that vary according to the section of the country. Clay, limestone, marl, cement rock, etc., are used.

How "ALPHA" Cement is Made

The raw materials for cement-making contain lime, silica, alumina and still other constituents. These materials are excavated, weighed, dried, proportioned with great care, and then ground to a fine powder. This ground raw material is then subjected to an intense heat, over 2700° F., in great rotary kilns, until it is "calcined to incipient

fusion,"—to use the chemist's terms. The clinker formed by this process is again ground—this time to an impalpable powder —so that more than three-fourths of it will pass a screen containing 40,000 meshes to the square inch. This twice-ground and thoroughly burned fine powder is Portland Cement.

The best grade of Portland Cement mixed one part cement and two parts standard sand, gives a tensile strength on "standard tests" of from 390 to 450 pounds in 28 days, which is several times the strength of "natural" cement, the strongest mortar material known up to the discovery of Portland Cement. Moreover, concrete made of Portland Cement continues for months, probably for years, to gain strength. Just how long it continues to grow stronger is not definitely known, but it is sufficient to be assured that properly built cement structures are practically imperishable. They stand fire, water, and wear, eliminate painting and repairing; keep interiors cool in summer and warm in winter, are attractive and sanitary. With so many advantages, it is scarcely to be wondered at that cement construction is increasing by leaps and bounds.

Portland Cement hardens under water as well as out of it; hence it is doubly useful and makes easily possible structures that otherwise would present difficult problems.

"ALPHA" History and Policy

The brand—ALPHA CEMENT—was originally used in 1891 by the Whitaker Cement Company at Bonneville, New Jersey, now Alpha, New Jersey, when first the English Portland Cements and later the German Portland Cements were regarded as being of the best quality.

The Alpha Portland Cement Company, a pioneer manufacturer of American Portland Cement, was organized on April 8, 1895, and two days later a charter was granted to the new company by the state of New Jersey. The newly organized Alpha Portland Cement Company, about the middle of 1895, acquired the property of the Whitaker Cement Company at Alpha, New Jersey. The original equipment was two 40-foot kilns with a yearly output of 100,000 barrels.

During the period beginning December 1, 1895 to November 30, 1896, the first full year in which actual records of the production were kept, there were manufactured 208,544 barrels of ALPHA CEMENT. The original plant at Alpha was increased by 1899 to ten kilns 60 feet long with a capacity of 2,000 barrels daily. In 1901 a second plant was built at Alpha which had a capacity of 4,500 barrels daily. Both of these plants have since become obsolete and have been abandoned.

In 1902 the Martins Creek Portland Cement Company, Martins Creek, Penna., which had established a mill on the Delaware River about seven miles above Easton, Penna., was purchased, and a second large plant at the same point was acquired in 1905 from the National Portland Cement Company, Martins Creek, Penna. These plants have been so developed that their present daily capacities are 3,500 barrels and 7,000 barrels ALPHA CEMENT.

The plant of the Buckhorn Portland Cement Company at Manheim, W. Va., was purchased in 1909 and now has a daily capacity of 2,500 barrels. In the latter part of 1909, the Catskill Portland Cement Company, Catskill, New York, and in 1917 the plant of the Thomas Millen Company, Jamesville, New York, were purchased. These two plants have present daily capacities of 3,500 barrels and 1,500 barrels of ALPHA CEMENT respectively.

All of these early purchases were confined to mills in the east, but in the latter part of 1920, three plants in the middle west were purchased; namely, The LaSalle Portland Cement Company, LaSalle, Illinois; The Burt Portland Cement Company, Bellevue, Michigan and The Ironton Portland Cement Company, Ironton, Ohio. These three plants have since been improved and at present the LaSalle plant has a daily capacity of 4,500 barrels; the Bellevue plant a daily capacity of 2,000 barrels and the Ironton plant a daily capacity of 3,000 barrels.

In December, 1922, the plant of the Continental Portland Cement Company, Continental, Missouri, which is just seven miles from St. Louis, was acquired. It has been enlarged since the purchase and now produces 4,500 barrels of ALPHA CEMENT daily.

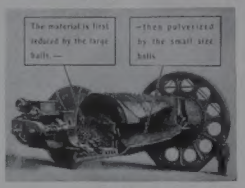
The property of the Phoenix Portland Cement Corporation at Birmingham, Ala., was purchased in May, 1928, having originally started operations in March, 1927. This plant, now known as our "Morton" plant, is

ILLUSTRATED STORY OF A

One of the busy ALPHA CEMENT Plants, Mill No 3 Martins Creek Pa

150,000 Tons of Cement Rock brought down by blast of 15 Tons of Dynamite (oval)

Cement Rock going through Gyratory Crusher

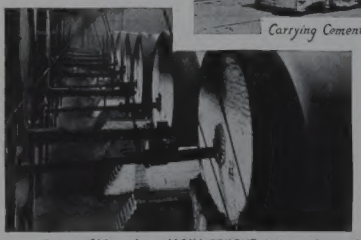


Sectional View of Two-Compartment Mill

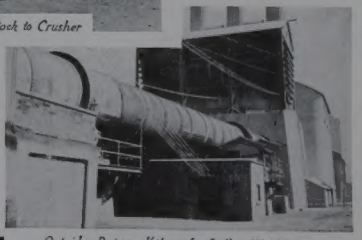
ALPHA Cement Rock Quarry

Carrying Cement Rock to Crusher

Electric Shovel at Work

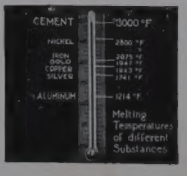


Rotary Kilns where ALPHA CEMENT is burned



Outside Rotary Kiln, La Salle Ill Plant

Cement Rock being carried to Crusher (Left)



Loading ALPHA CEMENT in boat Cementon, N Y Plant on Hudson River (Right)

BAG OF ALPHA CEMENT

Distributing Clinker in Open Storage by Electric Crane after It Comes from Rotary Kilns The Same Crane also Conveys the Clinker to the Finishing Mills

Inclined Elevator to carry clinker to Storage

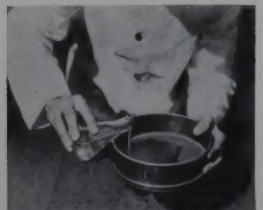
Stockhouse, Ironton Plant, Ironton, Ohio

Testing a Cement Briquette for Strength

ALPHA Cloth Bags are filled through valve in bottom end and contain 94 lbs net

ALPHA Laboratory Scene

ALPHA Bags traveling to loading platform



Cement is ground so fine that it will pass through a Sieve that actually holds water

An Example of Ancient Cement Construction

Nearly four-fifths of any test sample will pass through this Sieve that holds water

modern in every respect and has a daily capacity of 4,000 barrels of ALPHA CEMENT.

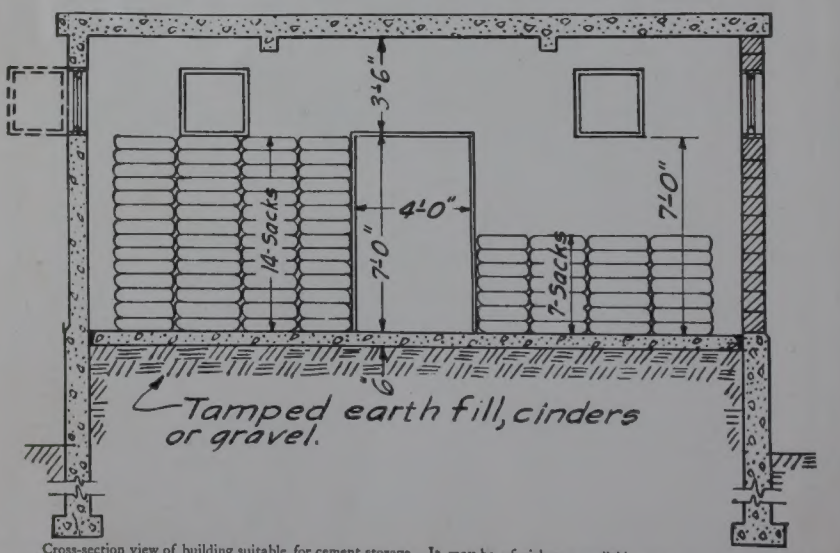
With the acquisition of these plants, the Alpha Portland Cement Company now owns ten plants, strategically located with respect to distribution and the use of cement and serving a territory extending from the Atlantic Seaboard to the Mississippi River. See the map on page 1, showing the location of the ten ALPHA CEMENT plants. From its inception, the Alpha Company has enjoyed a steady growth, both in number of plants operated and capital employed.

The Alpha Company has always maintained the policy of manufacturing one grade of Portland Cement and to have that of such a quality that it would be a credit to the Company behind the brand. The annual capacity of the Alpha plants has been increased from 100,000 barrels in 1895 to more than 13,000,000 barrels—a daily average of 36,000 barrels at present. Neither sharp competition nor zeal for increased output at low cost has ever been allowed to lower the quality of ALPHA CEMENT. And ALPHA service is kept on a par with the high quality of ALPHA CEMENT.

How to Store Portland Cement

Portland Cement is usually sold in cotton or paper bags containing 94 pounds net, conveniently considered as one cubic foot, volume measure. For the export trade cement is packed in barrels or drums. For use on larger building operations and in cement product factories it is sometimes sold in bulk. Cotton bags are used a number of times and are bought back by cement manufacturers and dealers when in good condition, thus reducing the package cost to the cement user. Bags which have become wet are unsuited for further use as cement containers and cannot be returned for credit.

Cement can be safely stored almost indefinitely if protected against moisture. With good facilities it is frequently stored for many weeks—occasionally several months—



Cross-section view of building suitable for cement storage. It may be of either monolithic concrete or cement block construction. Where it is not feasible to lay the floor on a gravel or cinder fill, the floor must be reinforced and carried by beams supported by cement piers, and the foundation wall should have openings that will permit free circulation of air beneath the floor. Footings should be to firm foundation below frost line.

without damage to quality. But it must be remembered that cement has a very strong affinity for moisture and even though protected from direct contact with the latter, cement stored where subjected to air currents may soon absorb enough moisture from the atmosphere to affect its strength. In order to keep it in perfect condition cement must be stored where it is not only dry, but secure from drafts as well.

The illustration on page 8 shows a cement storage shed which may be built either of reinforced cement or of cement masonry construction. Doors and windows should be restricted in number and size to barely meet absolute requirements for movement in and out and for light. They should fit tightly and must be kept closed. The cement floor should be placed on a well compacted cinder or gravel fill at proper grade so that the floor surface will be about one foot above the driveway level. If it is desired to place the floor higher, for convenience in unloading and loading, the construction should be carefully designed reinforced work. The floor ordinarily should consist of slabs 6 inches thick, of 1 : 2 : 3 concrete, in order to make it dense. Each sack of cement occupies about 2 square feet of floor area or 1¼ cubic feet, volume measure in the storehouse.

If cement is to be stored in a frame building, roof and walls should be thoroughly inspected to make sure that they are dry and wind-proof. Tar paper applied outside and inside, is probably the cheapest dependable wall covering. That portion of the floor on which the cement is to be stored should be stripped and covered with building paper on which should be placed an additional thickness of tongued and grooved flooring. Rooms or compartments in the storage building should be of moderate size and ceiling height not over 10 feet.

Cement stored for short periods is often piled 12 to 15 sacks high, alternate courses lengthwise and crosswise, to prevent overturning. To prevent caking or "warehouse set," the piles should be limited to seven sacks in height if storage is to be for a period longer than a few days. Piles of cement to be stored over an extended period should be covered with paper as a further protection from drafts, and should not be placed nearer than 1 foot to the side walls.

"Warehouse set" is merely the caking or compacting of the sacked cement when heavy loads are packed upon it. This is remedied by rolling the sacks on the floor. The presence of lumps which do not break up under light rolling indicates permanent injury to the cement by the absorption of moisture. For important work sacks containing such lumps should be discarded. For unimportant or mass work sacks containing lumps may be used after the latter have been screened out.

Cement cannot be safely stored on the ground. Even during the progress of construction work in which it is being used, cement should be piled on board mats, canvas, building paper or similar material. If piled in the open, tarpaulins sufficient to entirely cover the pile must be available for use over night and in case of rain.

"How to Store Cement" is the title of a bulletin published by the Portland Cement Association. It explains in detail the proper methods of storing cement in sacks and will be mailed to you free of charge upon request.

Large contractors and others interested in the economical handling of cement in bulk may receive a copy of the Association's booklet "Bulk Cement" with latest information on the subject.

Returning Cement Sacks

Cotton cement sacks are one of the few containers of common necessities which may be returned (if in usable condition), for credit. When the return feature of the cloth sack is considered, it is an extremely economical package. As cement sacks are filled an average of about eight times before they become unfit for service, an average of at least seven out of every eight sacks received by the user can be returned for credit if carefully handled, stored and bundled for safe return transit. Thus, where the user pays a sack deposit or service charge of 10 cents per sack, if he returns seven out of every eight sacks the net cost of the package to him is 1¼ cents per sack. Moisture ruins and tearing greatly damages cloth sacks and users should beware of both. Cement sacks are too costly to use for other purposes and should always be returned for credit as soon as convenient. Paper sacks ordinarily cost the user more, but many prefer the paper package because it need not be preserved after use.

Materials, Proportioning, Mixing and Placing

GOOD cement is necessary to make good concrete. But Portland Cement, no matter how good, cannot make good concrete unless mixed with sand, pebbles, broken stone or similar materials that are suitable.

ALPHA CEMENT is uniform, meeting the most severe engineering and other specification requirements, thus relieving the user of any concern in that direction.

On the average, cement probably constitutes about one-fifth of the bulk of concrete. The "aggregates"—sand, pebbles, gravel or stone—make up the other four-fifths. For best results these materials must be acceptable as regards cleanness, gradation and durability. In the following tests, suggested to determine the qualities of sand or gravel it is very important that representative samples be used. If aggregates are found to vary quite noticeably in various parts of the supply, a number of samples, perhaps five or six, should be taken.

Cleanness. Two tests are available for determining the cleanness of aggregates. The silt test indicates the relative amount of harmful fine matter, such as clay and silt, which may be present. The colorimetric test determines the presence of humus or other organic matter which is injurious to strength. Fortunately these tests are both quite simple to understand and to perform.

The Silt Test. The relative amount of excessively fine material in a sample of aggregate may be found by placing it in a 32-ounce graduated bottle, so that the dry material reaches the 14-ounce mark. Water is added until water and aggregate occupy the space up to the 28-ounce mark. The bottle is then shaken vigorously for one minute. The sediment is allowed to settle until the water is clear. If the layer of sediment deposited on the sand is greater than one ounce, as indicated by the graduations on the bottle, the material should be washed before using in concrete work.

The Colorimetric Test. Organic impurities are even more dangerous to the strength of concrete than is excessively fine matter. The colorimetric test, as developed at the Structural Materials Research Laboratory, Lewis Institute, and recently adopted by the American Society for Testing Materials, may be depended upon to indicate the presence of organic matter in the sand, with the exception of certain rare deposits of lignite. Small but harmful quantities of impurities are seldom discovered by visual inspection.

The colorimetric test is performed by filling a 12-ounce graduated prescription bottle to the 4½-ounce mark with the sand to be tested. A 3 per cent solution of sodium hydroxide is then added until the volume of sand and solution, after shaking, amounts to 7 ounces. The contents of the bottle is shaken thoroughly and let stand from 12 to 24 hours. If the solution resulting from this treatment is colorless, or has a milky or a light yellowish color, the sand may be considered sufficiently free from organic impurities for use in any cement work. If the solution is darker than straw color the sand is unsuited for important concrete work such as roads, pavements and building construction. If the solution appears brownish throughout (darker than plate 3 of the accompanying chart) it is not suited for any kind of concrete work and should not be used.

The sodium hydroxide (ordinary caustic soda) required for the solution may be obtained from any drug store. An ounce of sodium hydroxide in stick or pencil form dissolved in pure water will make 32 ounces of the 3 per cent solution required for this test.

Gradation of Materials. Ideally graded material for cement work contains particles varying in size from fine to the coarsest which can be used. Greater strength and better wearing qualities are obtained with less cement by the use of a preponderance of coarse particles, with only sufficient of the smaller sizes to fill up the intervening spaces, thus obtaining greater density and watertightness and smoother surface texture.

A given volume of coarse particles has less surface area than the same volume of smaller particles. Therefore less cement and water "paint" is required to coat the surface of a given volume of coarse particles

COLORIMETRIC TESTS FOR SANDS

[DESCRIBED ON PAGE 10]

COLORS OF TREATED SANDS WITH SUGGESTED RANGES OF APPLICATION

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ALPHA CEMENT — HOW TO USE IT

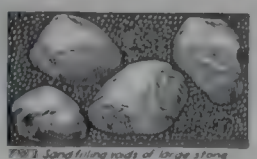


FIG 1 Sand filling voids of large stone

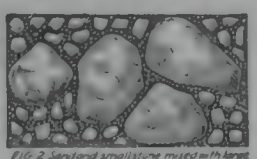


FIG 2 Sand and small stone mixed with large

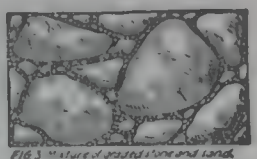


FIG 3 Mixture of gravel, stone and sand

than is required for the same volume of fine particles. A mixture of one part cement to five parts well graded aggregate frequently develops greater strength than one part cement to three parts of fine sand.

Only occasionally nature has provided gravel properly graded for most efficient use in concrete. Therefore, the practice has been well established of screening out the "sand" or material finer than ¼ inch from the "pebbles" or material coarser than ¼ inch, so that the two may be recombined in definite proportions. Commercial producers of these materials furnish sand and pebbles screened and washed, as required.

"Bank run" gravel may be separated into "sand" and "pebbles" by shoveling it over a screen having meshes ⅜-inch apart, set at an angle of sixty degrees with the ground. Owing to the angle at which the gravel strikes the screen, and the tendency for even dry sand to clog the corners of the screen somewhat, such a screen will be found to divide the material at approximately the ¼-inch size. For contractors and others using the screen frequently, the type shown in the accompanying illustration is recommended. It consists of large rods with clear spaces ⅜-inch wide between, electrically welded to horizontal support rods.

Sand. The coarse graded sand required for economical use in concrete is not to be confused with fine sand used for plastering and sand blasting. Not more than 6 per cent of concrete sand should go through a 100 mesh sieve (having 100 openings to the linear inch in each direction) and the greater part of it should be coarser than the 50 mesh sieve. Crushed stone screenings, if free from dust and dirt, will be found about equally acceptable with sand of similar gradation. Screenings almost always contain more or less dust, however, and for this reason are generally considered inferior to sand.

Pebbles. Pebbles, or screened gravel as commonly known, may be used in as large proportions as possible without producing rough or unsightly surfaces or lack of sufficient density. Broken stone of similar gradation may be used almost interchangeably with screened gravel, but for most uses the latter is preferred at the same cost, for its smoother working qualities. The largest size pebbles, broken stone or similar material permitted must not exceed in greatest dimension one-half the thickness of the section in which used.

In very thick walls, such as foundations, dams and other massive work, large rock or field stone can be safely used, provided they are clean, damp, and so placed as to be entirely surrounded by concrete.

Weights of Fine and Coarse Aggregates. It is impossible to give the weight of one cubic yard of sand, gravel or crushed stone without knowing certain conditions relative to the material in question. For instance, depending upon the percentages of various sized particles and whether the material is packed or loose, crushed limestone will vary from 1.23 to 1.43 tons per cubic yard.

A field determination of the weight may be made by weighing a cubic foot of the material after which the weight per cubic yard may be computed. The weight per cubic foot determination may be made in a box which is exactly 12 inches square and 12 inches deep, inside dimensions.

The following table shows the weight in tons per cubic yard when the weight per cubic foot is known and shows the variations in weight per cubic foot of several materials.

Weight Per Cu. Foot in Pounds	Weight Per Cu. Yard in Tons
75	1.01
80	1.08
85	1.15
90	1.22
95	1.28
100	1.35
105	1.42
110	1.49
115	1.55
120	1.62
125	1.69

Variations in Weight Per Cubic Foot of Sand, Gravel and Crushed Stones

Material	Min.	Max.	Aver.
Sand	90	117	103
Sandstone	74	116	95
Limestone	93	113	102
Granite	86	120	103
Trap Rock	94	125	109
Gravel	87	110	99

One bag of Portland cement equals one cubic foot and weighs 94 pounds net. Loose unpacked cement weighs approximately 84 pounds per cubic foot.

ALPHA CEMENT — HOW TO USE IT

Recommended Mixtures and Maximum Aggregate Sizes

	Cement	Sand	Pebbles or Stone	Maximum Size of Particles in Inches
	1			
	1			
	1			

ALPHA CEMENT — HOW TO USE IT

Durability of Aggregates. Cement construction can hardly be strong if made of weak materials. Therefore such soft materials as shale, slate, and other rock which crumbles, slivers or peels off, should be avoided. Most gravel will be found dependable, so far as durability is concerned, as will also granite, trap rock and most limestone.

There is a wide variation in the hardness of slag, owing to the varying conditions under which it is produced. Hard and generally acceptable slag is available for cement work in many localities. Slag should be well seasoned before using.

Cinders for Concrete. Cinders may be used where lightness is more desirable than strength. Cinders are light and porous, and are considerably more friable or crumbly than the other aggregates. The principal advantages of cinder concrete are that it is a good insulator against sound and heat, that it has lightness, fireproofness, is easily cut and sufficiently soft to allow nails to be easily driven into it. Cinders from plants that maintain high temperatures in their furnaces are more desirable, as they, as a rule, are fused to a clinker and are free from fine material. Ashes from anthracite coal or wood are undesirable as they do not fuse to a clinker, but are reduced to a fine flake-like ash and will produce a very weak and brittle concrete.

Cinder concrete is very frequently used for the floors of tall buildings and in the manufacture of cement products such as building block and brick. Cinder aggregates absorb more water in the mixing than do gravel or broken stone. Concrete made with cinders is usually placed with minimum ramming in order not to crush the particles, thereby increasing the area to be covered by the cement.

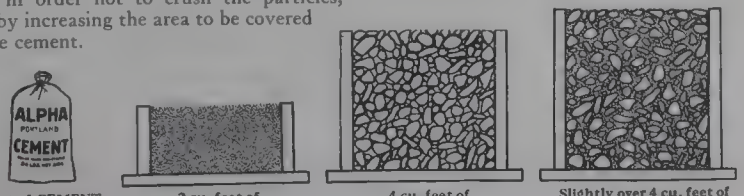
Proportioning Mixtures

Arbitrary methods of proportioning the materials for concrete, that is specifying a certain mix, are commonly used. The table on page 12 shows the proportions usually recommended for the various classes of work. The proportions indicated are to be used in measuring by volume. One part cement to 2 parts of sand and 3 parts of screened gravel (pebbles), for example, may be proportioned for a "1-sack batch" by taking 1 sack (which is 1 cubic foot) of cement, 2 cubic feet of sand and 3 cubic feet of screened gravel (pebbles). The resulting volume, as shown in Table 1, page 15, is 3.9 cubic feet. Similarly, a 1 sack batch of 1:2½:5 concrete would require 1 sack of cement, 2½ cubic feet of sand and 5 cubic feet screened gravel (pebbles) or crushed stone. The resulting volume would be 5.4 cubic feet.

With the above method of proportioning, it is assumed that the sand is dry. In most cases, however, the sand is damp. Moisture in the sand will cause it to bulk or swell in volume as much as 25 percent. For accuracy in proportioning by volume, it is necessary to make a correction when measuring damp sand. A simple determination for the bulking of damp sand may be made as follows:

Dry and weigh a measure of the dry sand. Weigh an equal volume of the damp sand. Divide the net weight of the dry sand by the net weight of the damp sand and multiply the result by the number of cubic feet required in the batch.

Example: Required one bag of cement; two cubic feet of sand and four cubic feet of stone. One cubic foot of the dry sand (loose) weighs 100 pounds. One cubic foot of the damp sand (loose) weighs 80 pounds. One hundred divided by 80 equals 1.25; 1.25



1 bag of CEMENT (about 1 cu. foot) | 2 cu. feet of SAND | 4 cu. feet of STONE | Slightly over 4 cu. feet of CONCRETE

Illustration of a 1:2:4 mix. Note that as the sand merely fills the voids of the stone and the cement fills the voids of sand, the seven cubic feet of material make a batch of only a little over 4 cubic feet of concrete. Beginners in cement construction often err in thinking that the volume of the concrete will equal the total volume of materials used.

multiplied by 2 equals 2½. Use 2½ cubic feet of the damp sand in each batch.

In this case, if no correction were made, the proportion would be approximately 1:1½:4, instead of the required 1:2:4. An excess of water would be required in order to work the concrete into place with the result that a poor quality of concrete might be produced, containing a high percentage of voids and having a strength below normal.

The three right-hand columns of Table 1 provide information as to the quantities of materials necessary for 1 cubic yard of mortar or concrete. Thus, 1 cubic yard of 1:2:3 concrete will require 7 sacks of cement (column 7), 14 cubic feet of sand (column 8) and 21 cubic feet of screened gravel (pebbles) or crushed stone (column 9).

Effect of Amount of Mixing Water. Recently a new method of specifying the quantities to be used has been presented to the engineers of the country as the result of many years of research on cement and concrete. This method takes advantage of the relationship between the strength of concrete and the relative amount of water and cement in the batch. It has been found from this research that for given materials and conditions of manipulation the less mixing water used the stronger will be the concrete so long as the mixture is workable. Since the strength of the concrete varies with the ratio of the volume of mixing water to the volume of cement, this relation is referred to as the water-cement ratio law. It is the basic law upon which the quality of every cubic yard of concrete placed depends.

With average materials meeting standard specifications, the compressive strengths to be expected for different amounts of mixing water are indicated in Table A. These strengths should be obtained when the concrete is well mixed and kept damp after placing.

TABLE A

Mixing Water U. S. Gal. per Sack of Cement	Compressive Strength at 28 days Lb. per sq. in
5	3800
5½	3400
6	3000
6½	2600
7	2300
7½	2000
8	1750
8½	1500

Not only does the amount of mixing water control the strength of concrete but it affects other qualities in a similar manner. Most important of these are the permeability and durability. Too much water results in permeable concrete that is unsuited for structures which are to be watertight. Such concrete will not withstand weathering satisfactorily. The bond strength, flexural strength and resistance to wear are also dependent upon the amount of mixing water used.

By applying the water-cement ratio law it is possible to design concrete mixtures having certain definite predetermined strength and other qualities. Table B gives a few examples of the amount of mixing water recommended for use in concrete for certain structures or conditions of exposure.

TABLE B
CLASSES OF CONCRETE FOR DIFFERENT DEGREES OF EXPOSURE

Class of Concrete (Expected Strength at 28 days lb. per sq. in.)	Maximum Quantity Mixing Water U. S. Gal. per sack of cement (94 lb.)	Type of Structure or Degree of Exposure
3000	6	Pavements, piles, pressure pipe, tanks. Thin structural members in severe exposure. Walls, dams, piers and all structures exposed to severe action of water, frost, sea and alkali water
2500	6¾	Sewers, bridges, thin walls, dams, piers and structures exposed to moderate action of water and frost
2000	7½	Ordinary enclosed reinforced concrete buildings. Bridges and retaining walls of heavy sections in moderate exposure
1500	8¼	Mass concrete, basement walls, etc., protected from water or severe weather conditions

The specified amount of mixing water includes the water that is in the aggregates as moisture and proper allowance must be made for this moisture in determining the amount of water to be added at the mixer. The moisture may be determined by drying representative samples of the aggregates. The difference in weight before and after drying is the amount of moisture in that quantity of aggregate. When it is not convenient to make these tests the corrections for moisture may be based on the approximate quantities in the following table:

TABLE C
APPROXIMATE QUANTITY OF FREE WATER CARRIED BY AVERAGE AGGREGATES

Condition of Aggregate	Approximate Quantity of Free Water
Very wet sand	¾ to 1 gal. per cu. ft.
Moderately wet sand	About ½ gal. per cu. ft.
Moist sand	About ¼ gal. per cu. ft.
Moist gravel or crushed rock	About ¼ gal. per cu. ft.

*TABLE 1

QUANTITIES OF MATERIAL REQUIRED FOR VARIOUS MIXTURES OF MORTAR AND CONCRETE

Mixture (1)	Quantities of Materials for a One-Sack Batch (2) Cement in Sacks	(3) Sand Cu. Ft.	(4) Pebbles or Stone Cu. Ft.	Volume in Cubic Feet of a One-Sack Batch (5) Mortar	(6) Concrete	Quantities of Materials for 1 Cu. Yd of Compacted Mortar or Concrete (7) Cement in Sacks	(8) Sand Cu. Ft.	(9) Pebbles or Stone Cu. Ft.
1:1½	1	1⅓	...	1.75	...	15⅓	23	....
1:2	1	2	...	2.1		12⅜	25½	
1:2½	1	2½	...	2.5	...	11	27½	
1:3	1	3	...	2.8	...	9¼	28¾	
1:1:1½	1	1	1½	...	2.3	12	12	17¼
1:2:3	1	2	3	...	3.9	7	14	21
1:2:4	1	2	4	...	4.5	6	12	24
1:2½:4	1	2½	4	...	4.8	5½	14	22½
1:2½:5	1	2½	5	...	5.4	5	12½	25
1:3:6	1	3	6	...	[illegible]	4¼	12½	25

TABLE 2

QUANTITIES OF MATERIALS REQUIRED FOR ONE SQUARE YARD OF CONCRETE SLAB OF VARIOUS PROPORTIONS AND THICKNESS

Thickness of Slab in Inches	PROPORTIONS—CEMENT, SAND, STONE 1:1½:3 Cement Bags	Sand Cu. Yds.	Stone Cu. Yds.	1:2:3 Cement Bags	Sand Cu. Yds.	Stone Cu. Yds.	1:2:3½ Cement Bags	Sand Cu. Yds.	Stone Cu. Yds
6	1.2200	.06834	.13500	1.1133	.08334	.12330	1.0267	.07662	.13332
7	1.4233	.07973	.15750	1.2989	.09723	.14385	1.1978	.08939	.15554
8	1.6266	.09112	.18000	1.4844	.11112	.16440	1.3689	.1022	.17776
9	1.8300	.10251	.20250	1.6700	.12501	.18495	1.5400	.1149	.19998
10	2.0333	.11390	.22500	1.8555	.13890	.20550	1.7111	.1277	.22220

The above figures are based on Coarse Aggregate containing 40% voids. For aggregates graded coarser than ¼ inch the voids will seldom be less than 40%. For each additional percent of voids add 1% to the amount of materials given in this table

TABLE 3

MATERIALS REQUIRED FOR 100 SQ. FT. OF SURFACE FOR VARYING THICKNESS OF PLASTER

Proportions	1:1		1:2		1:2½		1:3	
Thickness (in.)	Cement (sacks)	Sand (cu. yd.)	Cement (sacks)	Sand (cu. yd.)	Cement (sacks)	Sand (cu. yd.)	Cement (sacks)	Sand (cu. yd.)
⅛	2.2	0.08	1.5	0.11	1.3	0.12	1.1	0.13
¼	3.0	0.11	2.0	0.15	1.7	0.16	1.5	0.17
¾	4.5	0.16	2.9	0.22	2.5	0.23	2.2	0.25
1	6.0	0.22	3.9	0.29	3.3	0.31	3.0	0.33
1¼	7.5	0.27	4.9	0.36	4.2	0.39	3.7	0.41
1½	9.0	0.33	5.9	0.43	5.1	0.47	4.5	0.50
1¾	10.5	0.39	6.9	0.50	6.0	0.56	5.4	0.60
2	12.0	0.45	7.9	0.58	6.9	0.64	6.2	0.69

If hydrated lime is used it should be added in amounts of from 5 to 10% by weight of the cement.
Hair is used in the scratch coat only in amounts of ⅛ bushel to 1 sack of cement.
These figures may vary 10% in either direction due to the character of the sand.
No allowance is made for waste

*Tables 1 to 6 inclusive, on pages 15 and 16, are intended to cover general concreting practice. Additional useful tables are given as follows: Weights of Aggregates, page 11; Recommended Mixtures and Maximum Aggregate Sizes, page 12; Compressive Strengths Expected for Mixing Water, Table A, page 14; Classes of Concrete for Different Degrees of Exposure, Table B, page 14; Approximate Quantity of Free Water Carried by Average Aggregates, Table C, page 14; Slump Test Tables, page 19; Typical Concrete Strengths for an Ordinary Mix and a high early strength ALPHA Concrete, page 20; Areas of Round and Square Reinforcing Rods, page 29; Board Feet in Various Sizes and Lengths of Lumber, page 29; Data on Various Concrete Masonry Walls, page 43; Materials for Cement Stucco, page 52; Recommended Coloring Materials, page 52; Bearing Area of Soils, page 72; Dimensions of Silos, page 89; Dimensions of Septic Tanks, page 95.

TABLE 4

MATERIALS REQUIRED FOR 100 SQ. FT. OF SURFACE FOR VARYING THICKNESS OF COURSE

Thickness	1 in.			2 in.			4 in			5 in		
Mix	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone
1:2	3 9	0 29		7 9	0 58							
1:1 1	4 2	0 15	0.15	8.3	0.31	0 31						
1 1 1½	3 7	0 14	0 20	7.3	0.27	0 41						
1 1½ 2½	2 6	0 14	0 24	5 1	0 28	0 47						
1 1½ 3							9 4	0 52	1 04	11 7	0 65	1 30
1:2 3							8 6	0 64	0 95	10 8	0 80	1 19
1 2 4							7 4	0.55	1 10	9 3	0 69	1 37
1 2½ 4							6 9	0 64	1 02	8 6	0 80	1 27
1:2½ 5							6 2	0 57	1 14	7 7	0 72	1 43
1:3 6							5 2	0 58	1 16	6 5	0 73	1 45

Thickness	6 in.			7 in.			8 in			9 in		
Mix	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone
1:1½:3	14 0	0 78	1.56	16.4	0.91	1.82	18.7	1.04	2.08	21 1	1 17	2 34
1 2 3	12 9	0 95	1.43	15.0	1.11	1.67	17.2	1.27	1.90	19 3	1 43	2 14
1 2 4	11 1	0 82	1.64	12.9	0.96	1.92	14.8	1.10	2.19	16 7	1 23	2 47
1 2½ 4	10 3	0 95	1.53	12.0	1.11	1.78	13.8	1.27	2.03	15 5	1 43	2 29
1:2½ 5	9 2	0 86	1.72	10.8	1.00	2.00	12.3	1.14	2.29	13 9	1 29	2 57
1:3 6	7 9	0 87	1 71	9 2	1 02	2 03	10.5	1 16	2 32	11 8	1 31	2 61

NOTE. Quantities expressed in the following units
Cement . . . sacks; Sand . . . cubic yards; Pebbles or broken Stone . . . cubic yards

TABLE 5

MATERIALS REQUIRED FOR 100 SQ. FT. OF SIDEWALKS AND FLOORS FOR VARIOUS MIXTURES AND THICKNESS OF COURSES

Thickness of Course in Inches	Wearing Course				Base Course								
	1:1½		1:2		1:2:3			1:2½:4			1 2½ 5		
	Cement	Sand	Cement	Sand	Cement	Sand	Stone*	Cement	Sand	Stone*	Cement	Sand	Stone*
½	2 4	0.13	2 0	0 15									
1	4 8	0 26	3 9	0 29									
1½	7 2	0 40	5 9	0 43									
2	9 6	0 53	7 9	0 58									
4					6.5	0 48	0 72	5 2	0 48	0 77	4 6	0 43	0 86
4					8.6	0 64	0 95	6 9	0 64	1 02	6 2	0 57	1 14
5					10.8	0.80	1 19	8 6	0 80	1 27	7 7	0 71	1 43
6					12.9	0.96	1 44	10 3	0 95	1 53	9 2	0 86	1 72

Quantities of cement are expressed in sacks, aggregates in cubic yards
* Stone is used to include screened gravel (pebbles) or broken stone

TABLE 6

APPROXIMATE QUANTITY OF MIXING WATER REQUIRED FOR CONCRETE

Mix		Approximate Mix by Volume as Usually Expressed (Damp Aggregates Measured Loose)			Approximate Total Amount of Water Required, Gallons per Sack of Cement
Cement	Volume of Aggregate after Mixing	Cement	Aggregate		
			Fine	Coarse	
1	2¾	1	1¼	2½	5 to 5½
1	3½	1	1½	3	5½ to 6
1	3¾	1	2	3	6 to 6½
1	4½	1	2	4	6 to 6½
1	5½	1	2½	5	7¼ to 7¾
1	6¾	1	3	6	8¼ to 8¾

Finally, remember always to use the smallest quantity of mixing water that will produce a workable mix

ALPHA CEMENT — HOW TO USE IT

The proportioning of a concrete mix using fixed amounts of cement and water in their specified ratio is best done by making trial batches. An estimate can be made of the approximate mix that can be used for the particular job and a trial batch made using these proportions. It may be found that in the next batch more sand or stone can be used and good workability still obtained or the mix may be too stiff so that less aggregate will have to be used. Each time the proportions are changed the amount of water to be added must be corrected for the moisture in the aggregates. Two or three trials will usually give a mix that will have the desirable workability and at the same time be economical.

A simple example may help to illustrate the method of correcting for moisture. Suppose that a concrete tank is to be constructed. Since this is to be watertight, not more than 6 gal. of water should be used with each sack of cement. Assume that the contractor estimates he can use a $1:2\frac{1}{2}:3\frac{1}{2}$ mix and that the sand is moist and contains about ¼ gal. of water per cubic foot and the gravel also contains ¼ gal. per cubic foot. The $2\frac{1}{2}$ cu. ft. of sand will contain ⅝ gal. and the $3\frac{1}{2}$ cu. ft. of stone ⅞ gal. of water or a total of $1\frac{1}{2}$ gal. The amount of mixing water to be added to a one bag batch will then be 6 gal. less $1\frac{1}{2}$ gal. or $4\frac{1}{2}$ gal.

How to Figure Amounts of Materials

The first step in calculating quantities is, of course, to figure the total cubic space to be occupied by the concrete, which is learned by the simple method of reducing the dimensions to like units of measurement; for example, having all dimensions, feet or fractions of feet, and multiplying breadth and thickness together. For example, if a floor or driveway is to be 30 feet long by 12 feet wide and 6 inches thick, we have 30 by 12 by ½ equals 180 cubic feet, which divided by 27, the number of cubic feet to the yard, gives 6-2/3 cubic yards of volume.

Figuring a Foundation. A foundation that is to be 1 foot thick, 10 feet high, 25 feet wide and 40 feet long would be figured as 1 by 10 by 23 equals 230 for the short wall and 1 by 10 by 40 equals 400 for the long wall. The reason for using 23 as the building length of the short wall is that if the long wall is figured the full length, its thickness will of course lessen the length of the short wall one foot at each end. As there are two short walls and two long ones, the totals of 230 and 400 would be double, giving 1260 cubic feet, from which should be deducted space occupied by doors and windows.

Amounts of Cement, Sand and Stone. The simplest rule for mixing a batch of concrete is to take the proportions as a table of cubic feet. Thus, if the proportion is $1:2\frac{1}{2}:5$, use 5 cubic feet of stone, $2\frac{1}{2}$ of sand and 1 of cement.

Table 1 will be found very useful in calculating the quantities of sand and gravel, or stone, required for a one-bag batch of mortar or concrete, and in computing the volume of the resulting mortar or concrete. It will be found equally valuable in finding the quantities of material required for the job.

It will be observed from Table 1, that the volume of finished concrete will overrun slightly when the rule is followed of using the same number of cubic yards of stone as there are cubic yards of volume in the job to be undertaken. Thus, when five yards of stone are used in a $1:2\frac{1}{2}:5$ mixture the table gives the result of 5.4 yards of finished concrete. This difference comes mainly because the amount of sand used is slightly in excess of actual voids.

Example of Use of Table 1

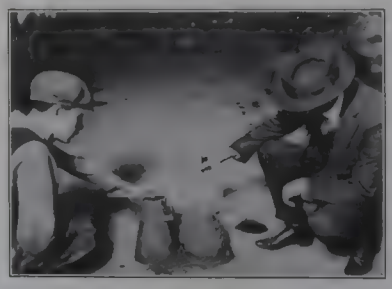
If 100 cubic yards or 2700 cubic feet of volume are to be filled with concrete of a $1:2\frac{1}{2}:5$ mixture, the quantity of cement required is found by referring to column 7, following it down to the ninth figure from the top (in the horizontal $1:2\frac{1}{2}:5$ line) which indicates that 5 sacks of cement are required per cubic yard, therefore 500 sacks (125 barrels) for 100 cubic yards of $1:2\frac{1}{2}:5$ concrete.

Similarly, by reference to column 8, it is found that $12\frac{1}{2}$ cubic feet of sand is required per yard of concrete, or 1250 cubic feet, equal to 46.3 cubic yards, for 100 cubic yards. Column 9 is used in the same manner to obtain the stone required, which is just twice the amount of sand, 2500 cubic feet or 92.6 cubic yards.

Or, the calculation may be reversed. To find the number of one-sack batches required for 100 yards of 1:2½:5 concrete, follow down column 6 to the corresponding horizontal, indicating that each one sack batch of this particular mixture occupies 5.4 cubic feet. Then the number of batches required will equal 2700 divided by 5.4 or 500. Since each batch requires 1 sack, 500 sacks are required for the entire work. Columns 3 and 4 indicate sand and stone required by each batch, each figure as given being multiplied by 500.

Control of Consistency

Accurate Control. The importance of controlling the consistency or amount of mixing water used can not be too strongly emphasized. Accurate control may be had only by the use of apparatus which will weigh or measure by volume the exact amount of water required in each batch of concrete.

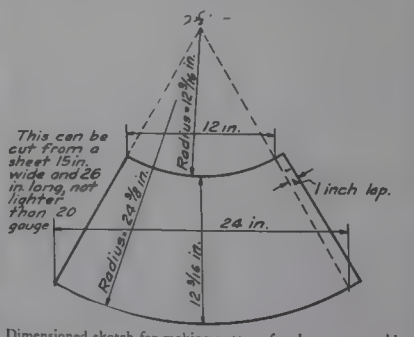


Interesting steps in making the slump test. Above, carefully withdrawing mold from the specimen. Below, measuring the slump.

Slump Test. The slump test is sometimes used for control of consistency, but is subject to certain errors which must be considered if satisfactory results are obtained. For this test a cone-shaped No. 20 gauge or heavier galvanized sheet metal form is used. It is four inches in diameter at the top, eight inches in diameter at the bottom and twelve inches high. It may be made to order quickly in any tin shop.

The form is placed large end down on a smooth non-absorbent surface and the freshly mixed concrete is placed inside in layers about four inches thick. Each layer is rodded 20 to 30 times (to remove voids or air pockets) with a $\frac{5}{8}$-inch pointed steel rod, 21 inches in length. After rodding the last layer of concrete, the top is struck off with a trowel so that the mold is exactly filled. The mold is then lifted off with a steady vertical motion. The difference in height of the concrete before and after removing the mold is called the slump.

When all other conditions (amount of cement, sand and stone, time of mix, etc.) are equal, an increase in the amount of mixing water causes an increase in the slump. When using this test the following points should be remembered. A batch of concrete may contain sufficient water for the proper degree of workability when properly mixed. If it is undermixed, however, it will look dry and show a small slump. The coarse aggregates containing large particles will have a tendency to slump less than those containing



Dimensioned sketch for making pattern for slump test mold

only small particles. The slump will be less if too long a time elapses between the time of mixing the concrete and filling the mold.

The slump test should be used only where means for accurate measurement of the water cannot be provided, and then only under the following conditions: Determine by trial measurement of the water the least amount that may be used with the materials on hand and for the type of work to be done, making sure that the trial batches are thoroughly mixed. Make the slump test on this concrete and use that slump for additional batches. If different materials are used it may be necessary to establish a new slump limit. The illustrations on page 18 show the method of making this test, and for making the mold pattern.

Mixtures for Tamping and Pressure Processes. Cement block, building tile, brick and other products made on heavy tamping or pressing machinery and cement sewer pipe and drain tile made by a rotary trowelling or pressure (packer head) process, are good examples of cases where mixtures must contain less water than required to produce workable or plastic concrete. Since such concrete is not workable, maximum strength is not obtained. Sufficient water may and should be used so that wet markings appear slightly on the sides of the products, indicating that moisture has been flushed to the surface in the process. With a little more care in securing uniformity of operations, additional water may be used with the same machine speed.

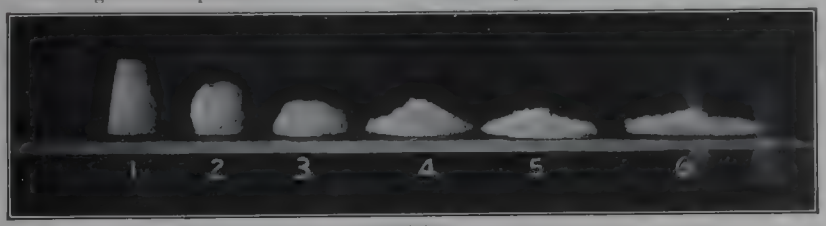


FIGURE 1

SPECIMEN	1	2	3	4	5	6
Water, in gallons per sack of cement	7	7	7	7	7	7
Mixture, by volume	1 2½ 4	1 2½ 3	1 2½ 2	1 2 4	1 2 3	1 1½ 2
Slump, in inches	1	5¼	7½	7	8½	9½
Strength, lbs. per sq. in.	3980	4050	4110	3960	4290	4130
Sacks of cement per cu. yd. of concrete	4 7	5 4	6 1	5 1	5 8	7 6

The above photograph and table show how the slump varies when the proportions of cement, sand and stone are changed and the amount of water per bag of cement remains constant. Note also that the strength of the concrete is practically the same for all mixes

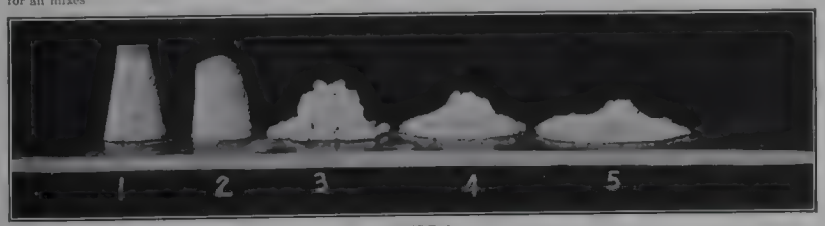


FIGURE 2

SPECIMEN	1	2	3	4	5
Water, in gallons per sack of cement	6	6½	7	7½	8
Mixture, by volume	1 2 4	1 2 4	1 2 4	1 2 4	1 2 4
Slump, in inches	¼	2¼	6½	7	8½
Strength, lbs. per sq. in.	*4000	4850	4030	3820	2540
Sacks of cement per cu. yd. of concrete	5 1	5 1	5 1	5 0	5 0

*The mixture in column 1, containing six gallons of water, did not produce a plastic mix with these proportions and therefore the water-cement ratio strength relation does not apply

ALPHA CEMENT — HOW TO USE IT

Quality of Water. It has come to be almost an axiom, that water fit for concrete must be pure enough to drink. While this is a good standard, it is probably somewhat exaggerated, for no harmful results worthy of mention are known to follow the use of any water which is reasonably clear and free from alkali or commercial acid solutions.

High Early Strength Concrete

"By following usual standards in mixing time and curing"

The builder is concerned with the problem of building economically and permanently. Early use of the structure sometimes results in worth-while savings to the owner. So far as this problem relates to concrete, most satisfactory results are obtained with ALPHA CEMENT and the following instructions for the production of high early strength concrete are prepared for Alpha users.

Both the early and ultimate strength will depend upon the following conditions:

First: Quality and condition of the materials used. Use ALPHA CEMENT; clean, sharp sand and a well-graded coarse aggregate of durable quality.

Second: Gallons of mixing water per bag of cement. Use only enough mixing water to produce a concrete with a "workability" which will permit proper placing of the concrete. As long as workability is maintained, a decrease in the gallons of water per bag of cement means an increase in strength and the quantity of mixing water has a much greater effect on the early strength of concrete than at later periods. For the same degree of workability, rich mixes require less water per bag of cement than lean mixes and the result is stronger concrete at all ages but more particularly at the earlier periods.

Third: Thoroughness of the mixing operation. The materials should receive at least one minute of thorough mixing. If job conditions will permit, longer mixing time will add to the early strength.

Fourth: Proper placing of the concrete in the forms. Place the concrete to prevent segregation or separation of mortar and coarse aggregate. Tamp, puddle or spade the concrete to prevent the formation of voids.

Fifth: Proper curing of the finished structure. Furnish moisture to the finished structure to prevent too rapid drying of the surface. In winter weather artificial heat should be provided to keep the temperature above 60° F.

Sixth: Weather conditions. When the prevailing temperature of the air is less than 40° F., the mixing water or sand and coarse aggregates should be heated. Heating both the mixing water and aggregates will provide a still greater factor of safety.

The following table shows typical concrete strengths for an ordinary mix of 1:2½:4 and the high early strength Alpha concrete of 1:1½:2½:

Proportions cement sand and stone	Water gallons per bag of cement	Consistency or degree of workability	Compressive Strength lbs. per square inch		
			3 Days	7 Days	28 Days
1:2½:4	8	Wet	1,000	1,750	2,700
1:2½:4	6	Dry	1,500	2,200	3,500
1:1½:2½	**5.5**	**Wet**	**2,000**	**2,600**	**5,000**
1:1½:2½	**4.5**	**Dry**	**2,700**	**4,000**	**5,500**

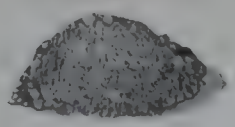
The consistency or workability indicated as "wet" is equivalent to a six-inch slump and the "dry" consistency is equivalent to a one-inch slump. It will be noted that the effect of reducing the quantity of mixing water from eight gallons per bag to six gallons per bag on a 1:2½:4 mix will change the consistency from "wet" to "dry," and increase the three-day strength from 1,000 to 1,500 pounds per square inch. It will also be noted that in the 1:1½:2½ high early strength Alpha mix only 5½ gallons of water per bag of cement is required to produce the "wet" consistency and a strength of 2,000 pounds per square inch at three days. This consistency is suitable for use in building construction where it is necessary to chute the concrete. For foundations, etc., where a stiffer mix can be used, quantity of mixing water can be further reduced to 4½ gallons per bag of cement, producing the "dry" consistency having a strength of 2,700 pounds per square inch at three days.

High early strength Alpha concrete is being used successfully in street paving, street repairs, floors, vaults, towers, foundations, etc. Every job has proved satisfactory and has resulted in a substantial saving as compared with other methods of producing high early strength concrete. It has the additional advantages of time-proven durability and unusually high ultimate strength.

ALPHA CEMENT — HOW TO USE IT

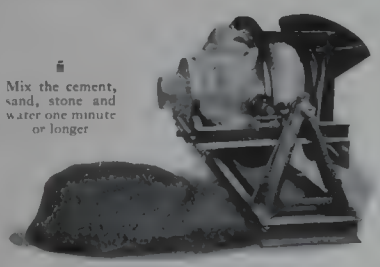
1
One bag of Alpha Cement, 94 lbs. net or 1 cu. ft.

2
1½ cu. ft. clean, sharp sand

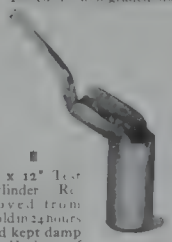


3
2½ cu. ft. well graded stone

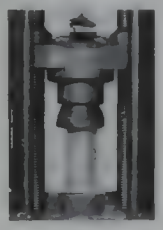
4
4½ gallons of water



5
Mix the cement, sand, stone and water one minute or longer



6
6" x 12" Test Cylinder Removed from mold in 24 hours and kept damp until time of test—48 hours later



7
Compressive strength of test cylinder more than 38 tons, or 2,700 lbs. per square inch in 7 days

Methods of Mixing

Good concrete can be made by hand mixing, but unless laborers are carefully watched and instructed as to the best way of turning materials, imperfectly mixed concrete is likely to result. Machine mixing is more dependable, especially in the batch type of mixer. These come in almost any desired capacity and are relatively low in cost. Many cement and building material dealers rent such mixers to their cement customers, and often farmers join in groups and buy power mixers.

Mixers of the batch type are preferable since measured materials must be put in the drum for each batch, while in the continuous type of mixers there is always possible some variation in moisture content or proportions of materials that may cause the concrete to lack uniformity.

Length of Time in Machine Mixers. Often concrete has been mixed for too short a period of time. Most mixer manufacturers recommend the number of revolutions per minute at which the drum of their machines should be revolved for best results. Whether mixed by hand or machine, mixing should continue until the mixture is of uniform color and consistency. As a general rule, no batch of concrete which is machine mixed should be removed from the drum until mixing has continued for at least one minute. In most cases no mentionable loss of time would result from mixing each batch two minutes, which would give considerably greater strength and uniformity to the concrete.

Working Methods in Hand Mixing. For measuring materials a bottomless box or frame of 1 or 4 cubic feet capacity should be placed on a board, filled to the required level, and lifted off. Mixing by means of shovelfuls or wheelbarrow loads is uncertain. A frame that holds 4 cubic feet, should be marked on the inside at various levels to indicate 1, 2 and 3 cubic feet.

A platform 8 by 14 feet made of tongued and grooved 1½ or 2-inch stuff so that tight joints will result, is necessary for hand mixing. A strip nailed around the outer edges on three sides will prevent the loss of cement that might be carried away when adding mixing water. Square-pointed shovels are necessary for turning the materials on the board. A sprinkling can, or hose with nozzle, a water barrel, measuring box, wheelbarrows, tampers, spading tools, a wood float, screen, steel trowel and possibly a groover and edger, are about all the tools needed.

In mixing a one-bag batch by hand in the porportions of 1:2:4, first spread out the two cubic feet of sand on the board. Distribute one bag of cement over the sand

as evenly as possible. Then with shovels, turn this material thoroughly, first dry and then wet, applying the water evenly. Now spread this mortar out and place the four cubic feet of stone on top.

The turning process must be resumed and continued until the mass is thoroughly mixed. It is better to err in the direction of turning the material too often than to fail to mix well enough. Streaks of cement indicate that the mixing is not thorough. It is better to keep the pile of stone wet beforehand, so it will already have absorbed some water. The method here described is not the only way by which concrete can be mixed. Where bank-run gravel has about the right proportions of sand and coarse material and is to be used, spread that out on the mixing board and put the cement on top. Turn with the shovel several times dry then sprinkle the material thoroughly and continue the turning process until the mass has been shoveled not less than four or five times. Shoveling the mixed materials into wheelbarrows will answer as one turning. A rake should not be used in mixing batches when the coarser material has been added as it draws the larger stone away from the smaller. Some use the rake to mix the cement with the sand.

Sand and cement should never be mixed long before the pebbles and water are added to complete the mixture, because all sand contains sufficient moisture to start a setting of the cement which would rob the concrete of some strength.

It is very necessary in mixing concrete that all of the particles of sand be thoroughly coated with a film of neat cement and water, and that the resulting mortar shall be sufficient to coat thoroughly the larger particles of broken stone so that the whole mass will be firmly bound together. Broken stone, especially some limestones, contain a great deal of fine dust. This prevents a good bond.

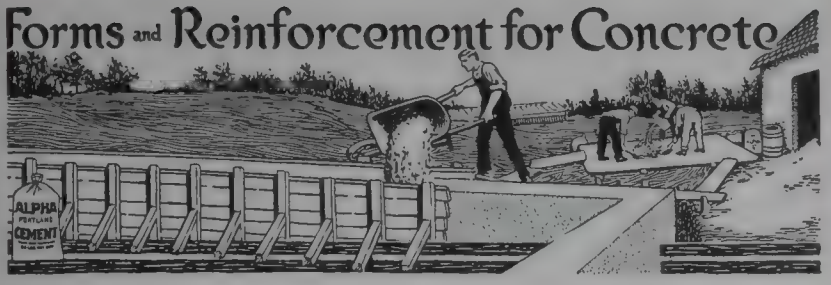
Placing the Concrete. Immediately after mixing the concrete should be placed. This suggests where possible to do so, the mixing platform, or the mixer, be located near the point where concrete is to be placed, making it convenient to shovel the concrete directly into forms.

Spading to Secure Density and Good Surface. Concrete batches of ideal consistency are spaded into place rather than tamped. A convenient tool for spading is an old garden spade, or a hoe which has been straightened out so that the blade is in line with the handle. Special spading tools are also made with perforations in the blades which assist to bring the sand-cement mortar against form faces while holding back the coarse particles in the concrete and in this way produce a smooth surface finish when forms have been removed.

Protection of Fresh Construction. Regardless of how carefully the materials for any cement work may have been selected, proportioned, mixed and placed, the resulting success or failure must depend largely on whether or not the concrete is protected against drying out after it is placed. If suitable protection is not afforded, the concrete cannot properly "moist cure" and instead of hardening, simply dries out as a result of evaporation of a large portion of the mixing water. Cement construction which exposes a large surface area to sun and wind, such as walks, feeding floors, barn-yard pavements, etc., must be protected against rapid drying out by a layer of some moisture-retaining material. Sand, sawdust, hay, straw, old canvas, burlap, carpets, or similar covering applied as soon as the concrete surface can be covered without marring it, accomplishes the purpose. Such coverings should be kept wet by frequent sprinkling for a week to ten days.

While the above methods of moist curing are followed for general construction work, very specialized treatment is practiced in concrete product factories in order to secure rapid hardening under accurately regulated conditions of humidity. The most acceptable method of curing is to place the newly made product in a tight steam chamber immediately after molding or casting, gradually raising the temperature until 100° to 125° Fahrenheit has been reached. Moisture is provided by pressure fog nozzles or exhaust low pressure steam to practically saturate the atmosphere without causing condensation on the contents of the chamber. Temperature and humidity are then kept constant for from 48 hours to 72 hours, at the end of which period curing has been accomplished equal to that usually resulting from ten days' to three weeks' storage in moist air at moderate temperatures.

Forms and Reinforcement for Concrete



IN order to use a concrete mixture, forms or molds are necessary so that the mass when hardened will have assumed the required shape and form. For a number of classes of cement construction and products, such, for instance, as sewers, silos, double monolithic building walls, cement block, brick and tile, there are various types of patented forms and machines which permit quite a range of adjustments to adapt them to various dimensions of structures or products for which they are designed. Such forms or molds are almost invariably made of metal, sheet steel being the material principally used.

A large part of cement building construction is, however, done by using wooden forms; and as it is rare for any two structures to be of exactly the same dimensions and detail throughout, more or less special form work has to be done for each particular job. It is possible, however, to design wood forms as unit panels, somewhat like that shown in Fig. 1, having dimensions of 2 by 4 feet or 2 by 6 feet or more, so that the forms may be used repeatedly, at least on certain parts of any square or rectangular structure.

Wood forms are often lined with galvanized iron or sheet steel to make them more durable and to assist in producing a smooth surface on the finished work.

Various kinds of lumber may be used for form construction. When moldings or decorative trim is to be reproduced in concrete, white pine is desirable as it may be worked easily; but white pine is rather expensive, and being soft is not very durable. Hard woods are also expensive and difficult to work. Norway pine and spruce are probably used most for form work.

Contrary to the usual practice in building construction, green lumber or lumber which is only partly air-dried will keep its shape in concrete forms for rectangular construction better than lumber that is kiln-dried. If kiln-dried lumber is used it should be thoroughly wet before concrete is placed. This is because the lumber will absorb the water from the concrete, and if the forms are made tight, as they should be, the swelling from absorption will cause the forms to buckle or warp. Oiling or greasing the inside of forms before use is recommended, especially where forms are to be used repeatedly as it prevents absorption of water and also assists in keeping them in shape when not in use.

It is often possible to build forms from stock lengths of lumber, without cutting and thereby wasting material. After use, forms so built may be carefully taken apart and the lumber can be put to other uses. A form for column footing, for example,

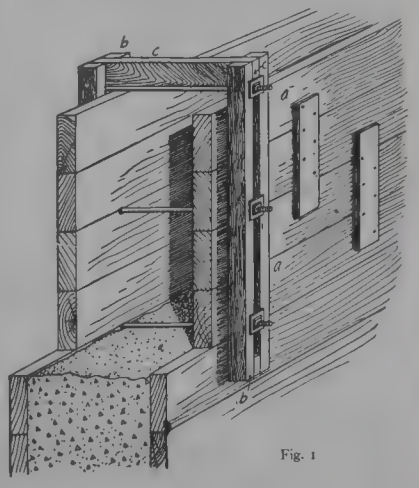


Fig. 1

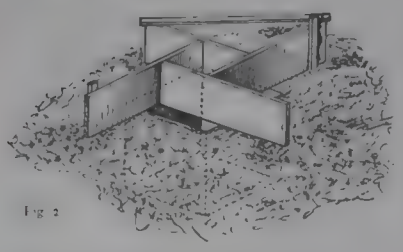


Fig. 2

may sometimes be made as shown in Fig. 2 without cutting lumber.

Form lumber should be free from loose knots or other defects and irregularities that would be reproduced by the concrete. Lumber that is planed on both edges and one side is preferable, as it will give a smooth surface finish to the concrete. It is very essential that lumber for form work, where the concrete is to be exposed, be of uniform thickness, as when nailed to the studs any inequalities of thickness will result in an irregular surface on the concrete. As a rule, 1, 1½ and 2-inch lumber is most used. The added cost of dressed lumber is more than offset by the convenience in handling, working up and placing. Tongued-and-grooved lumber is often used for form sheathing, although what is known as shiplap is better. Lumber having slightly beveled edges is preferred by many because when it swells the edges will mash together enough to result in tight joints; this prevents water from leaking away and carrying cement with it.

Usually 2 by 4's, 2 by 6's, or in extreme cases 2 by 8's are used as form studs. The volume of concrete, or weight that must be supported determines the dimensions and spacing of form studs. Forms constructed with one-inch sheathing, should have studs spaced not more than two feet apart, in order to prevent any bulging of the sheathing when subjected to the ramming of placing concrete, and its outward pressure until hardened.

Forms must be braced thoroughly when set up, and then held the correct distance apart by spacers, these being removed just before the concrete reaches them. Bolts or wire ties may be used to hold forms against the spacers and from spreading apart. If bolts are used they may be greased before concrete is placed so they can be driven out of the concrete easily when forms are removed. It is best to break the bond of the concrete around such bolts within 24 hours. This may be done by merely tapping them with a hammer. Wire ties are generally used and are cut when taking down forms, all of the wire, except the projecting ends, being left in the concrete. Fig. 3 shows how the forms are tightened against spacers by twisting the wire ties.

When a cement foundation is not to enclose a cellar or basement, it will often be found that the soil is sufficiently self-sustaining to permit depositing concrete in the foundation trench without forms, as in Fig. 4. For all work above ground, however, forms are required; these may be of such a type as that illustrated in Figs. 6 and 7.*

As many foundations are provided with a footing, this may sometimes be constructed by omitting to nail sheathing boards on the lower eight or ten inches of the form studs as resting in the foundation trench, thus allowing the first concrete deposited to spread out and form the footing. See Figs. 6 and 7.

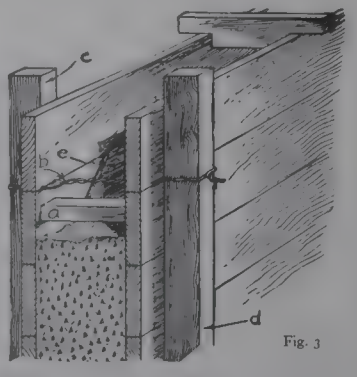


Fig. 3

*When the earth wall is sufficiently self-sustaining to permit dispensing with an outside form, only the single inner form section need be used except when the work has reached a point above ground, then, of course, two forms (inner and outer) will be required. For example, in Figs. 6 and 7 the form next to the earth wall could be omitted if the ground were firm.

ALPHA CEMENT — HOW TO USE IT

As concrete made with ordinary sand, gravel or stone weighs from 130 to 150 pounds per cubic foot, floor and roof forms particularly must be designed with a sufficient factor of safety to prevent them from sagging from their own weight as well as that of the concrete. Any sagging of forms will result in small cracks developing while the concrete is hardening, and these will gradually widen, preventing the construction from having the desired strength. Enough braces, struts, and studs must be used to prevent forms from sagging. Various methods of bracing are shown in Fig. 5 and elsewhere.

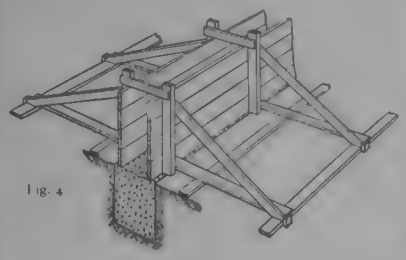


Fig. 4

Forms should be designed with every regard for economy of lumber, and when assembling them as few nails as possible should be used. In some cases screws and clamps used instead of nails will permit removing forms with the least hammering and least injury to the fresh concrete. No very wide boards should be used in form construction, from four to six inches being the preferred widths, with eight inches as the maximum. Wider boards are difficult to keep from warping and bulging.

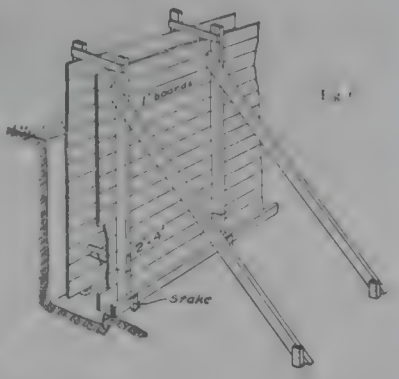


Fig. 3

Forms for floors laid on the ground and for walks, should consist of two-inch lumber having a width equal to the desired thickness of the floor or walk and should be staked in position. Very few nails if any are needed in forms for walks, feeding floors and similar pavements. Stakes well driven will hold form boards in proper position.

Straight walls and flat floors usually require the simplest types of forms. Corners, offsets, bends and various kinds of breaks or projections from the plain surface, such as in columns, beams, cornices, and walls with openings and angles increase the cost.

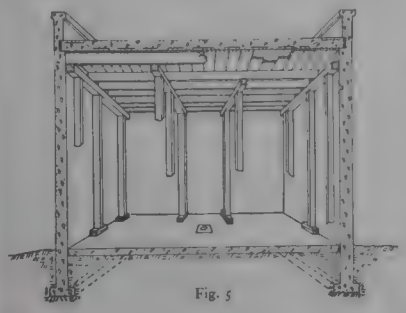


Fig. 5

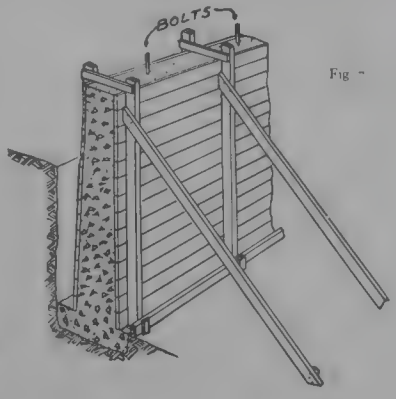


Fig. 6

With care in taking down forms it is possible to use lumber several times, so the longer it is in service the less the percentage of original cost to charge to any one job. For some classes of work form lumber can be used more than ten times.

Unit Forms. The greatest economy is gained by building forms so that they can

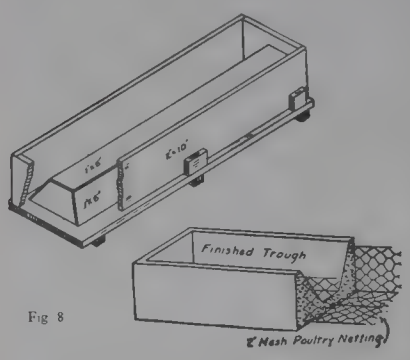


Fig 8

be repeatedly used. Most people who have paid any attention to a contractor at work building the foundation of a small house, for example, have noticed that he brings to the work a set of standard form panels and sets them up by bracing or otherwise. Such panels represent a convenient form unit permitting most repetition in use. Observe Fig. 9. These units should be carefully handled and each time thoroughly cleaned when taken down preparatory to subsequent use. But few standard panel sections are required. For example, the standard unit may be 2 by 4 feet. Supplemental sections may be 2 by 2 feet, 1 by 2 feet and 1 by 4 feet. A little experience in setting up such forms gained by using them once or twice, will indicate how many of the smaller sized panels may be profitably provided and kept on hand to permit closing up stretches of wall of different lengths. The principal precaution to take in making such panels is to see that the frame studs on which the sheathing is nailed or screwed are cut up and assembled with such precision that the bolt holes for bolts used in assembling sections shall exactly coincide no matter how the form panel may be turned, thus making it possible to set up forms true to line.

Miscellaneous Pointers on Forms and Their Use. Concrete will not stick to forms that are oiled each time before use with a mixture of boiled linseed oil and kerosene, equal parts of each, but if not so oiled they should at least be thoroughly wetted down. They should be carefully cleaned of all particles of adhering concrete after removal and be wet down immediately before again placing concrete in them.

Forms for the ordinary types of square or rectangular stock watering troughs, hog feeding troughs (Fig. 8), and manure pits are all of a simple type, and when the earth is firm enough to be self-sustaining only an inside form will be necessary. Otherwise, form construction simply amounts to one frame within another; that is, two bottomless boxes of different sizes, one set inside of the other. Forms for square or rectangular tanks that are to be built above ground should provide for a batter or slope on the inside of the structure so that the expansion from freezing water will be spent upward instead of against the tank sides. Fig. 8 illustrates this. For such tanks as cisterns, which are usually placed wholly underground, of course a

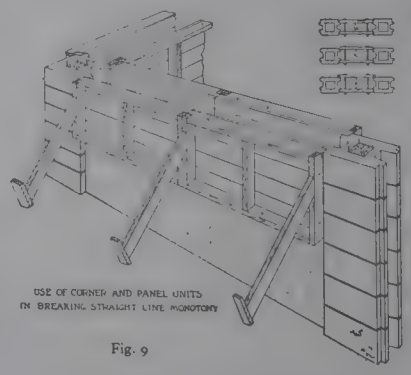


Fig. 9

form is needed for the cement roof or cover slab. This is in the nature of a floor supported by studs.

There is no possibility of stating with precision the time when forms may safely be removed from any piece of construction.

This varies entirely with weather conditions and the mass of concrete. Whenever the structure is one which need support no weight but its own, such as a building wall of medium dimensions, all above ground, forms can sometimes be removed in three or four days. There is no advantage, however, in removing forms too early

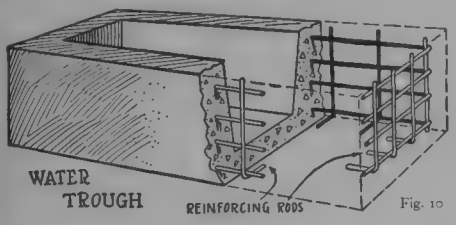


Fig. 10

because the forms afford desirable protection to the concrete in preventing it from drying out during the first few days. Forms for heavy arches, for floors supported above ground and roofs, must all be left in place from ten days to two, three or four weeks. It is a wise plan to leave forms in place a few days longer than may seem absolutely necessary, just to be on the safe side. Such a precaution often marks the difference between failure and success.

Reinforced Cement Construction Materials to Use

"Reinforcing" is the name given to the practice of embedding steel in concrete, to increase its strength against tension, or forces that tend to pull it apart. Concrete, like many building stones, is strong in compression; that is, in bearing loads which are placed directly upon it, but is relatively weak in tension; that is, in resisting forces which tend to pull it apart.

The materials usually employed to reinforce concrete are steel rods of various forms, and woven mesh fabric similar to some of the common types of wire fencing. The reason for this is that specification requirements governing the practice of reinforcing concrete call for steel that possesses certain chemical and other qualities. Perhaps by far the commonest kind of reinforcing used is plain round or square or twisted square bars.

While it is possible to use old barbed wire and other waste materials to reinforce concrete, there are many difficulties and uncertainties attending their use. This is particularly true of barbed wire. The material is very difficult to place and to keep in proper place while depositing concrete, and unless reinforcing is placed and held in correct position while concrete is being deposited, a great deal of its possible effectiveness is lost. Barbed wire and other fencing is purposely manufactured so it will stretch, an essential for fencing purposes which makes it less reliable as a reinforcing material.

If wires are to be substituted for the steel rods recommended, then one should be certain that the quantity of wires used equals in cross-sectional area the amount of rods for which substituted. The same holds true of using mesh fabric in place of rods. Mesh fabric is generally used instead of rods for floor, roof and pavement reinforcing.

Fig. 11—Reinforcing bars as placed in cement walls

On cement work that has been the subject of engineering design only one general grade of reinforcing steel is considered. This can be obtained from any of the steel companies or through local building materal dealers.

Without going into details as to the physical and chemical properties of steel, it is sufficient to say that steel varies greatly in character; some stretches and bends easily while other kinds are stiff and brittle. This should lead one to realize that not all steel is equally well suited for reinforcing cement work.

Regardless of whether plain round or square, twisted-square or deformed bars are used, the steel should meet what are known as the "Standard Specifications for Steel Reinforcing Bars," of the American Society for Testing Materials. Practically all of the steel companies manufacture reinforcing steel that meets these specifications.

In estimating for reinforcing steel it is best to increase the estimate by 10 per cent over the actual amount calculated for, to cover shortage resulting from cutting.

Reinforcing steel not only strengthens concrete against tension but in many cases makes possible the attainment of a required strength in a structure with considerable economy of concrete. It also serves to prevent cracks that may otherwise result from expansion and contraction under temperature changes. The principal reason for using steel instead of other metals is that the ratio of expansion of steel under temperature changes is so nearly like that of concrete that the two expand in a practically equal degree; therefore, there is no "breaking of bond" between the concrete and steel.

Reinforcing is particularly necessary in tanks or troughs, where freezing is likely to increase pressure. Foundations rarely need reinforcing. Building walls above ground usually do. Note Fig. 11.

The subject of reinforced concrete is a technical one and cannot be touched upon from the standpoint of design. Reinforcing for any structure should not be chosen by guess, although it is possible to specify in an offhand way safe practice for small structures such as the usual barnyard watering tanks or troughs, feeding-troughs, etc. Usually ¼-inch or ⅜-inch rods are used in tanks that are not greater than 2 by 8 feet inside dimensions, and are spaced from 6 to 12 inches center to center, both vertically and horizontally throughout the structure. See Fig. 10.

In reinforcing cement construction the quantity of steel required in a structure may vary from ½ to perhaps 1½ per cent of the cross-sectional area of the concrete. Columns and beams under excessive loads require as much as 4 per cent or more of steel. These figures are of course only general and may vary considerably in individual cases.

Steel used for concrete reinforcement should be free from rust in the form of loose scale that would prevent the concrete from bonding properly with it. To be safe it should be brushed with a wire brush. Sometimes it is necessary to put the metal in a pickling bath, usually made by combining one part sulphuric acid and five or six parts of water, and left there long enough to remove the rust. The rods should be thoroughly washed in clean water to prevent any further action on the steel.

There are a number of patented types of deformed sheet metal marketed under various proprietary names used particularly in floor, roof-slab and partition construction, which in some cases serve as forms as well as reinforcing.

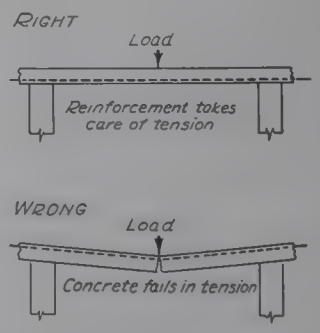


Fig. 12

Before depositing concrete all reinforcing rods should be fixed in proper position so they will not become displaced while placing concrete. This is particularly important for construction that must be fire-safe, since it is necessary that the metal have the benefit of a certain amount of concrete covering, not only to prevent the steel from being exposed but to insure

effective bond. Reinforcing rods in such a structure as a tank, a silo or a cistern, for instance, should be wired together where verticals and horizontals cross.

TABLE 7

AREAS OF ROUND AND SQUARE REINFORCING RODS

Diameter or Thickness in Inches	Round Rods Area in Sq. Inches	Weight in Pounds Per Foot	Square Rod Area in Sq. Inches	Weight in Pounds Per Foot
1/4	0491	167		
3/8	1105	.376		
1/2	1963	668	2500	850
5/8	.3068	1 043		
3/4	4418	1 502		
7/8	6013	2 044		
1	.7854	2 670	1 0000	3 400

In splicing reinforcing it should be lapped from 40 to 50 times its diameter. This method of joining is more effective as a rule than bending ends and hooking them together, since there is certain to be some slack where rods are so hooked, and if a strain is brought upon the concrete at such a place in the structure then the reinforcing is not effective in resisting tension. A ¼-inch rod should, therefore, be lapped with the rod which it joins not less than 12 and preferably 15 inches. Rods should be bound firmly together with wire wound around the lap. Patented "collar" clamps are also used. All rods used in beams and in floor and roof slabs should have the ends turned to an L-shaped loop or hook to form an anchor in the concrete. There should be at least 1 inch of concrete between the rods and the forms and never less than 2 inches between parallel rods.

When bending rods, bends should be made slowly. Force applied to the cold bar suddenly is quite likely to break it at the point of bending. Examine all bends and angles after made for cracks so as to detect any imperfections before placing the steel in the concrete. Reinforcing rods that are left projecting out of newly deposited concrete for the purpose of splicing other rods to them when work may be resumed should be protected against being struck or jarred, thus breaking the bond between the steel and the concrete. Reinforced concrete failures have resulted from the metal becoming misplaced while placing concrete. It is, therefore, essential that steel be placed exactly as called for in the plans. Note Fig. 12, illustrating correct and incorrect placing of reinforcement.

TABLE OF BOARD FEET IN VARIOUS SIZES AND LENGTHS OF LUMBER FOR USE IN ESTIMATING FORMS AND OTHER TIMBER WORK

Size of Timber in Inches	Length of Piece in Feet							
	10	12	14	16	18	20	22	24
1 x 2	1 2/3	2	2 1/3	2 2/3	3	3 1/3	3 2/3	4
1 x 3	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6
1 x 4	3 1/3	4	4 2/3	5 1/3	6	6 2/3	7 1/3	8
1 x 5	4 1/6	5	5 5/6	6 2/3	7 1/2	8 1/3	9 1/6	10
1 x 6	5	6	7	8	9	10	11	12
1 x 8	6 2/3	8	9 1/3	10 2/3	12	13 1/3	14 2/3	16
1 x 10	8 1/3	10	11 2/3	13 1/3	15	16 2/3	18 1/3	20
1 x 12	10	12	14	16	18	20	22	24
1 x 14	11 2/3	14	16 1/3	18 2/3	21	23 1/3	25 2/3	28
1 x 16	13 1/3	16	18 2/3	21 1/3	24	26 2/3	29 1/3	32
1 x 20	16 2/3	20	23 1/3	26 2/3	30	33 1/3	36 2/3	40
1 1/2 x 4	5	6	7	8	9	10	11	12
1 1/2 x 6	7 1/2	9	10 1/2	12	13 1/2	15	16 1/2	18
1 1/2 x 8	10	12	14	16	18	20	22	24
1 1/2 x 10	12 1/2	15	17 1/2	20	22 1/2	25	27 1/2	30
1 1/2 x 12	15	18	21	24	27	30	33	36
2 x 4	6 2/3	8	9 1/3	10 2/3	12	13 1/3	14 2/3	16
2 x 6	10	12	14	16	18	20	22	24
2 x 8	13 1/3	16	18 2/3	21 1/3	24	26 2/3	29 1/3	32
2 x 10	16 2/3	20	23 1/3	26 2/3	30	33 1/3	36 2/3	40
2 x 12	20	24	28	32	36	40	44	48
2 x 14	23 1/3	28	32 2/3	37 1/3	42	46 2/3	51 1/3	56
2 x 16	26 2/3	32	37 1/2	42 2/3	48	53 1/3	58 2/3	64
2 1/2 x 12	25	30	35	40	45	50	55	60
2 1/2 x 14	29 1/6	35	40 5/6	46 2/3	52 1/2	58 1/3	64 1/6	70
2 1/2 x 16	33 1/3	40	46 2/3	53 1/3	60	66 2/3	73 1/3	80
3 x 6	15	18	21	24	27	30	33	36
3 x 8	20	24	28	32	36	40	44	48
3 x 10	25	30	35	40	45	50	55	60
3 x 12	30	36	42	48	54	60	66	72
3 x 14	35	42	49	56	63	70	77	84
3 x 16	40	48	56	64	72	80	88	96
4 x 4	13 1/3	16	18 2/3	21 1/3	24	26 2/3	29 1/3	32
4 x 6	20	24	28	32	36	40	44	48
4 x 8	26 2/3	32	37 1/3	42 2/3	48	53 1/3	58 2/3	64
4 x 10	33 1/3	40	46 2/3	53 1/3	60	66 2/3	73 1/3	80
4 x 12	40	48	56	64	72	80	88	96
4 x 14	46 2/3	56	65 1/3	74 2/3	84	93 1/3	102 2/3	112
6 x 6	30	36	42	48	54	60	66	72
6 x 8	40	48	56	64	72	80	88	96
6 x 10	50	60	70	80	90	100	110	120
6 x 12	60	72	84	96	108	120	132	144
6 x 14	70	84	98	112	126	140	154	168
6 x 16	80	96	112	128	144	160	176	192
8 x 8	53 1/3	64	74 2/3	85 1/3	96	106 2/3	117 1/3	128
8 x 10	66 2/3	80	93 1/3	106 2/3	120	133 1/3	146 2/3	160
8 x 12	80	96	112	128	144	160	176	192

Figures given are Board Feet. Lumber is usually priced by the Thousand Board Feet. A piece 1 inch thick, 12 inches wide and 1 foot long, constitutes 1 foot Board Measure

A GREAT deal of cement work can be undertaken as well in winter as at other seasons. Indeed there is often more time and lower labor cost in winter than during the summer. Posts, drain pipes, rollers, slabs, watering troughs, tanks, floors, etc., can be completed indoors, and—with the exception of floors—the finished work can be put into place outside later. Such work can be done in barns, sheds, basements, etc.

All winter cement work must be done with extreme care. There must be established, through artificial means, the conditions that make for good work during favorable seasons of the year. For very large undertakings considerable equipment is necessary. For small jobs and moderately cold weather the equipment is simple and inexpensive.

There are various methods of protecting cement work in freezing weather. These include the heating of the materials and water to a temperature not higher than 145° F., and protection of the concrete until it is no longer in danger of disintegration through the action of frost.

Heating water and aggregates

Protective methods are usually applied progressively as the weather gets colder. Cement work hardens slowly at temperatures under 40° and in most climates there may be danger of freezing during the night even when the thermometer registers around 40° during the day. Therefore it is considered good practice to commence cold weather treatment at this temperature, not only as a precautionary measure, but also to hasten hardening.

Protecting newly laid walk with building paper and straw

Heating of the aggregates and suitable blanketing of the cement work after placing are the first treatments to be applied, and they are often entirely sufficient even when the temperature is as low as 20° Fahrenheit. The simplest type of heater consists of a section of old metal pipe or culvert inside which a wood fire is built, with the aggregate piled over it. Piles of sand and screened gravel should be kept separate and turned occasionally to make sure that the materials are thoroughly heated all through. Where live steam is available, a large steam coil or grid may be laid down on a floor and the material piled on it, the pile often being covered with a canvas to prevent heat from escaping.

Methods of covering the concrete after placing vary according to the nature of the construction. Foundations are protected

somewhat by the forms, and require only a covering of canvas or heavy paper, often blanketed with straw. Building paper covered with two or three inches of manure makes a very effective covering. This latter method is commonly used for walks and driveways, and as it should be applied immediately to be most effective, the paper should be supported on wooden strips only high enough above the concrete to prevent touching.

Protection for exposed walls and similar work above grade is more difficult. Canvas covering is placed around the work, being carefully joined together to prevent "frost bites" in small exposed spots. Charcoal or coke stoves are placed within buildings or enclosures where practical, radiators being substituted where steam may be had. Radiators are often placed on the outer surface of the wall, under the canvas. In the building of tanks, bins and other unroofed structures, it is particularly important that a canvas or other covering be placed over the top to prevent the dissipation of heat.

If concreting is to be done at sustained temperatures below freezing, mixing water also should be heated. If there is no steam boiler on the job perhaps the most efficient method of heating water is in large iron kettles over open fires. When steam is available, a steam pipe is usually exhausted in the water barrel. If there is running water but no steam, the water pipe may be connected to a heating coil made of a long pipe and return pipe which may be run through the aggregate heater. Water may be used at practically boiling temperatures.

In extremely cold weather it usually

An old steam boiler used to heat mixing water

A combined salamander and water heater

becomes expedient not only to heat the aggregates and the water, but also to introduce heat into the mixer drum in order to prevent loss of heat there. The openings in the drum are fitted with canvas flaps and a steam pipe exhausted within, or the drum heated by a patented heater constructed on the principle of a blow torch, using kerosene fuel. It is always wise to locate the equipment where protected from cold winds and storms as far as possible and also as convenient as may be to the points at which the concrete will be deposited.

Little benefit is derived from heating of the cement and under no circumstances should any reliance be placed on the heat generated by the cement in hardening, as some have wrongly advocated. A small amount of heat is given off in the reaction between the cement and the water, but it is too small to be of any assistance in the protection of concrete against freezing.

Common salt has been advocated and occasionally used in the mixing water to lower the freezing point. This practice is not recommended because sufficient salt to lower the freezing point more than four or five degrees cannot be used without fear of reducing the strength of the concrete, at the same time greatly increasing the possibilities of efflorescence, a chalky white deposit sometimes seen on masonry surfaces. At best salt only lowers the freezing point of water and does nothing to increase the very slow rate of hardening at these temperatures.

Calcium chloride is used with better success, but its use should be carefully prescribed for each particular case. Four pounds of calcium chloride to the sack of cement is the limit recommended under any circumstances, as greater quantities affect strength adversely and may cause efflorescence.

In order to do cement work in winter it is usually necessary to procure the sand and gravel or stone in advance, before the pits or other sources of supply become frozen up. Materials stored for winter use in concrete should be protected against moisture and in cement products plants are sometimes placed in large steam heated bins to facilitate handling and make sure all frost has been removed before using. Where necessary to store aggregates out in the open, heaters or steam pipes are often placed under or in the pile so that these may be utilized to thaw and heat the material when needed.

Fireproofing

No other structural material has given such a good account of itself when exposed to severe fire tests as concrete. It will not burn and is a slow conductor of heat.

Scarcity of timber in large sizes has resulted in a rapid advance in price of such material within late years and this has brought about a situation whereby absolutely fire-safe cement buildings can be built for the same cost or at least little greater cost than required for buildings that are thoroughly combustible.

Protection of Reinforcement. In all fireproof construction it is very necessary that reinforcing be held in proper position while concrete is placed so the steel will have a sufficient protective covering to prevent heat from warping or melting it. As a general rule reinforcing steel in floor slabs should be protected by not less than a 1-inch covering of concrete, in beams by not less than 1½ inches, and in columns by not less than 2 inches.

Chimney Work. Concrete is used largely and very successfully in chimney construction, from the requirements of the smallest cottage to those of the great smelters in the west employing stacks two or three hundred feet high. Unlined concrete chimneys have been successfully used where the temperature of the gases entering the chimney is 1000 degrees Fahrenheit or over. Even under continued exposure to the high temperatures of unusually hot fires, the surface of the concrete to a depth not exceeding a fraction of an inch may be partially calcined or reduced to a substance resembling unslaked lime. This thin layer of calcined concrete on the exposed surface transmits heat very slowly and therefore forms an efficient protection for the remainder of the mass, which is not heated to a sufficient degree to cause the slightest injury.

Concrete chimneys which are cast in place should not be exposed to any considerable heat, such as that from a large furnace or boiler, until 30 days old. This limitation should be observed in order to insure time for the concrete to cure thoroughly before it is exposed to the drying action which might evaporate off the water of crystallization.

Since it is necessary to reinforce concrete chimneys cast in place, using designs prepared by competent engineers, it is usually easier to build chimneys for residences, garages and moderate sized commercial buildings of precast cement units, such as ordinary building blocks or special chimney blocks. See page 40. These are carefully laid in 1:3 cement and sand mortar with inside joints pointed flush and trowelled smooth. Never lay chimney construction in lime mortar. If first class cement blocks are used and carefully laid, it will be unnecessary to use flue lining for the chimneys of ordinary dwellings where temperatures are moderate as compared with those which come from commercially operated boilers. Flue lining costs very little, however, and may be considered as safe and sane insurance by those who may doubt the efficiency of unlined flues.

In the past, masonry chimneys for small residences occasionally have been supported on timber wall brackets. Experience has shown this practice to be exceedingly dangerous and it should never be followed. Chimneys should rest on ample supports of cement construction. For the bearing capacity of various soils see paragraphs under "Foundations for Small Buildings," page 71. Footings for chimneys should go down to firm ground well compacted, and if exposed they must go below the line of maximum frost penetration.

Making Concrete Watertight

Joining Each Day's Work. Leaks in tanks, troughs, cisterns and similar structures sometimes result from the fact that no precautions were taken to join correctly the concreting of different days' work. When concreting is stopped, the surface in the forms should be left rough so that there will be an opportunity for the concrete placed the following day to bond to the old concrete. The surface should be well washed, and painted with a cement grout paint mixed to the consistency of cream, applied immediately before placing new concrete. If possible, concreting should be continuous.

Density by Proper Grading of Aggregates. Concrete may be made so dense that it will resist the passage of water even under very high pressure, or so porous as to constitute a good filter. Watertightness depends primarily upon gradation of the particles, plasticity or "workability" of the mass and upon the proportion of materials used, especially the mixing water and cement.

Proportioning concrete for water-tightness, hence for maximum density, depends upon obtaining in the mixture enough sand to fill the open spaces between the particles of large aggregate, and sufficient cement to fill the open spaces which remain in the combined sand and pebbles or stone.

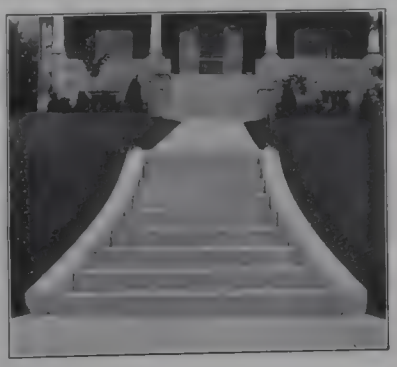
Hydrated lime, sometimes added to concrete mixtures, acts only as a void filler. The danger in it is that too much lime may be used, lowering the strength of the concrete and sometimes causing efflorescence, a white, chalky, deposit on the surface. A little more cement, without the lime, would produce a stronger, more watertight concrete.

Amount of Water. Most important of all is the proper control of the amount of mixing water in making watertight concrete. Referring to Table B, page 14, it will be seen that not more than 6 gal. of water per sack of cement should be used in mixing concrete for tanks. This amount includes the water that is already present in the aggregates so that the actual amount to be added at the mixer is not more than from 4 to 5 gal. The water should be measured for each batch. With reasonably well graded materials, this amount of water should allow the use of about a 1:2:3 mix.

Of almost equal importance is the proper placing of the concrete in the forms. Care must be taken to avoid any segregation of the materials. If the mixture is too wet or if too much coarse aggregate is used, the coarse materials will "bunch" and the mortar will run to the low spots. In placing concrete in deep layers, the excess water will rise to the top of the layer producing porous concrete near the top and hard, dense concrete in the lower part of the layer. Avoid this by using a mix that is not too wet.

Curing. After the concrete has set it is important that it be kept damp for a week or longer. The walls of tanks may be covered with burlap and the bottom covered with sand. The burlap and sand should be kept constantly damp by sprinkling. Tanks or reservoirs should not be filled with water until several weeks after completion.

Waterproofing Compounds. The fact that porous concrete has been made occasionally where watertight concrete was desired has led to the marketing of various compounds intended to increase the watertightness of concrete. These compounds are not necessary to securing watertight construction and many of them are of questionable composition, seriously reducing the strength of the concrete in some cases. The use of these "guaranteed" compounds is dangerous in that it is likely to encourage careless proportioning and mixing. A little additional cement, without these compounds, would produce stronger, watertight concrete.



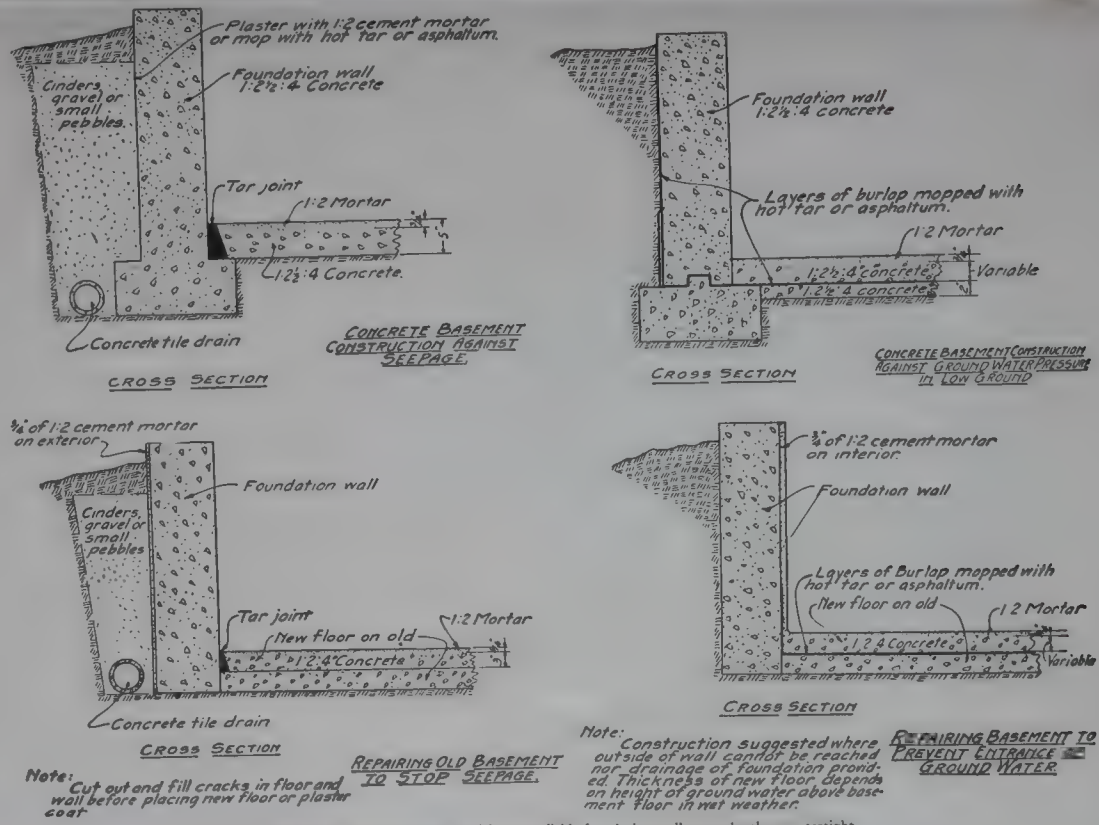
ALPHA CEMENT — HOW TO USE IT

Building a Watertight Tank or Cistern

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]

To Make a Basement Watertight, Using Monolithic Concrete Placed In Forms

1. [illegible]
2. [illegible]
3. If possible place concrete from footings to grade level at one continuous operation using just enough water so that cement will flush to the surface under light tamping and spading. If necessary to discontinue operations with basement wall partly completed fill the entire fill grained to the same level leaving the surface of the concrete rough and covered to protect it against drying out or becoming dirty. Clean the upper surface of the wall with a cement and water wash just before resuming the placing of concrete upon it.
4. Remove the forms as soon as practicable and while the surface is still damp fill up all holes or blemishes with mortar of 1 part cement to 2½ parts sand made from the same material as used in the wall. Then point the surface inside and outside with a cement and water wash, of the consistency of thick cream.
5. [illegible]
6. Place the basement floor as indicated in the sketch.
7. Place drain tile around wall as shown and run to a suitable outlet, unless soil is high and well drained. Place 4 inches or a foot of crushed stone or gravel under and around the tile.
8. In addition to the cement and water wash surfaces are sometimes mopped with hot tar or a suitable asphaltic preparation as well. For this treatment the surfaces of the walls must be absolutely dry, for these substances cannot work properly to dampen surfaces. The material should be applied as hot as possible, special care being taken that every minute area in the entire surface is entirely covered.
9. In filling up excavation place backfill [illegible] and when the earth is moist but not wet. Compact by tamping. Continue placing backfill in this manner until grade is reached, sloping the surface of the fill away from the house. After two weeks [illegible] tamp the surface again, to fill any pockets remaining after previous tamping.



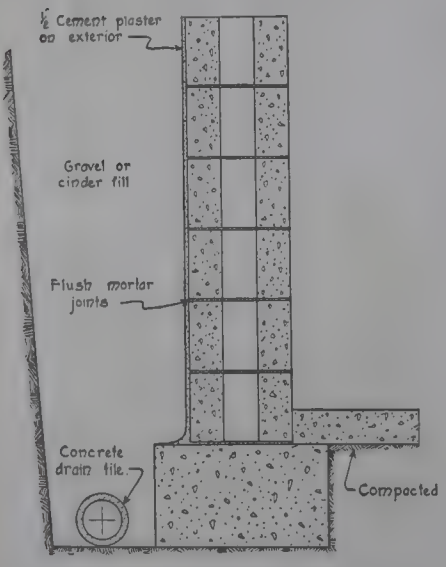
Methods of constructing and repairing monolithic foundation walls to make them watertight

ALPHA CEMENT — HOW TO USE IT

To Make a Watertight Basement Using Cement Block or Cement Tile Foundation Walls

1. With footing still damp, place first course of block in bed of 1:3 cement and sand mortar sufficiently deep to properly seat each block and level the course. Lay succeeding courses using plenty of mortar to provide maximum bedding area and buttering both ends of every block. Fill and strike all joints flush outside and inside.
2. Apply a coat of 1:2½ or 1:3 cement and sand mortar, washing over the surface with a calcimine brush while still soft.

Laying of the floor and drain tile and placing of the backfill are done in the same manner as for monolithic cement foundations. Inside of wall below grade may be plastered with cement mortar in the same manner as the exterior surface, if desired. In cases where it is impossible to plaster the exterior of the wall, similar coat on the interior may be used.



Recommended method of building a watertight basement wall with cement block

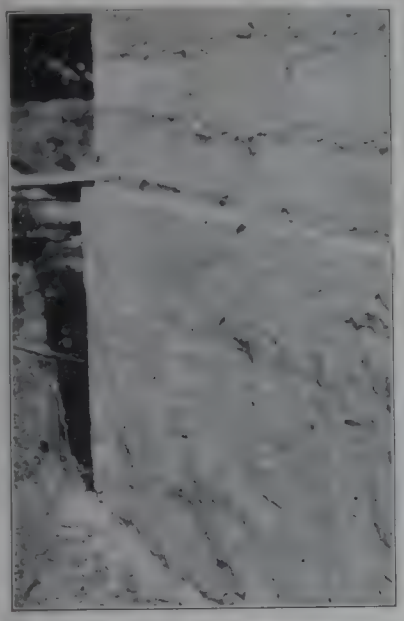
Waterproof Repair Methods

It is usually much easier to make concrete watertight by the use of good practice in the process of manufacture than it is to employ methods later to stop the passage of moisture already begun. However, a number of successful waterproofing repair methods are available, the choice between them being dependent upon the nature of each particular job.

Sodium silicate (ordinary water glass) or preparations containing it, are frequently found useful in sealing porous concrete as a means of stopping seepage. A solution made up of 1 part sodium silicate to 3 to 5 parts water, applied to the dry surface of the porous concrete will eventually fill the pores and render the surface watertight, if put on in two or more coats at intervals of 24 hours. Three coats are usually sufficient to seal almost any surface, although four applications will give better results on very porous surfaces.

Similar treatment is sometimes given substituting paraffin for sodium silicate. By this method the surface is thoroughly dried and warmed with a blow torch, the paraffin being applied with a brush as a thick liquid. It is then melted and driven into the pores by the heat and pressure of the flame. Pitch and other asphaltic materials are frequently applied to the wall with a swab or brush, giving good results in mild cases. For this treatment it is extremely important that the concrete be absolutely dry and the pitch as hot as possible.

These treatments are applied successfully on the inside of small tanks and cisterns, cellar walls and similar places where the leakage is relatively small and due to seeping through pores in the concrete rather than to open cracks or large breaks. For these reasons they are sometimes referred to as "dampproofings." Major waterproofing repairs are always made with rich Portland cement mortar or concrete used as the filler or coating. Wherever possible it is applied to the side of the wall or tank from which the water enters, but where this is not practicable it may be applied to the surface on which the water appears. Whereas sodium silicate, paraffin, pitch and other asphaltic paints must be applied to dry surfaces, cement mortars and washes are applied more successfully to moist surfaces.



A foundation wall of cement block properly plastered with cement mortar below grade

Methods of Repairing Leaks in Tanks and Cisterns Placed Below Ground

1. Serious general leaks through walls that are obviously porous, are usually best repaired by exposing the exterior wall surfaces and covering them with a ½-inch coat of cement mortar made of 1 part cement to 2½ parts fine to medium coarse sand. (Minor leaks, in the nature of light seepage, may be repaired by the use of sodium silicate solution, described in a preceding paragraph.)

If the surfaces to be plastered were originally given a smooth trowelled finish, the latter should be roughened with a bush hammer or similar tool, then moistened and painted with a thick cement and water wash before applying the new plaster coat.

2. Leaks through a structural crack in the wall can be stopped by chiseling out the crack, forming a V-shaped channel at least 1 inch deep, painting it with cement and water wash as described in the preceding paragraph, then filling the channel with cement mortar, firmly pressed and trowelled into place.

3. Water entering the tank through the floor indicates that there is considerable pressure behind it and suggests the need of a tile line running around the tank and to a suitable outlet. If it is impractical to relieve the pressure in this manner, a deep hole or sump should be arranged to take the pressure off the tank floor until repairs can be made.

The surface should be cleaned thoroughly, then scrubbing it with a cement and water wash, following this treatment immediately by placing over it a 2-inch mortar coat, made of a 1:2½ mixture of cement and building sand. More serious cases are treated by cleaning off the floor surface as suggested above, covering it, while absolutely dry, with a coat of hot pitch or other asphaltic preparation recommended for the purpose. A layer of burlap may be laid on the pitch and another coat of pitch applied. A 2-inch coat of cement mortar, as described above, may then be placed over the pitch. This treatment is preferably extended up on the walls for a distance of 12 to 18 inches. Water pressure must be entirely relieved for a period of at least one week, and preferably ten days to two weeks.

Where foundations are exposed to constant pressure of ground water, a coat of asphaltic paint is sometimes applied over the cement mortar

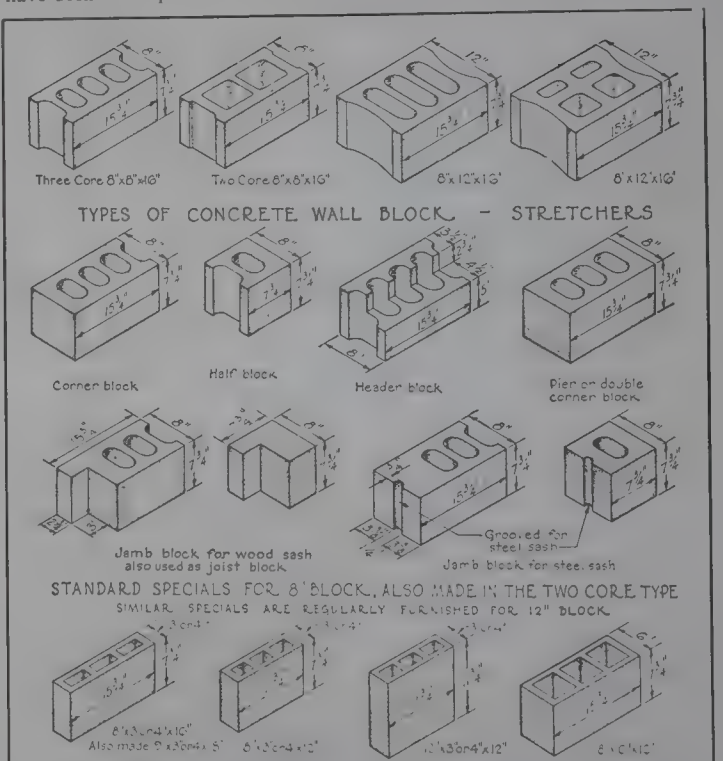
ALPHA CEMENT — HOW TO USE IT

Cement Block and Cement Building Tile

While many structures have been built of rock faced block and may be seen in use today, this type of cement block has fallen into disuse except for grade courses and occasionally the walls of farm buildings. This is due to the fact that the rock face pattern is not only inappropriate for other uses but it is usually unattractive and sometimes even ugly.

Of recent years the artistic possibilities of cement work have been given more thought and attention, with the result that cement block have been developed with surfaces of selected aggregates which equal and occasionally exceed in beauty and durability most natural building stone. These surfaces are produced with selected mixtures of Portland Cement and marble, granite, mica spar —in a variety of sizes and colors. No attempt is made to follow the irregular surface lines of hewn stone; modern cement block have flat faces—all true to plane, with definite sharp, straight corners.

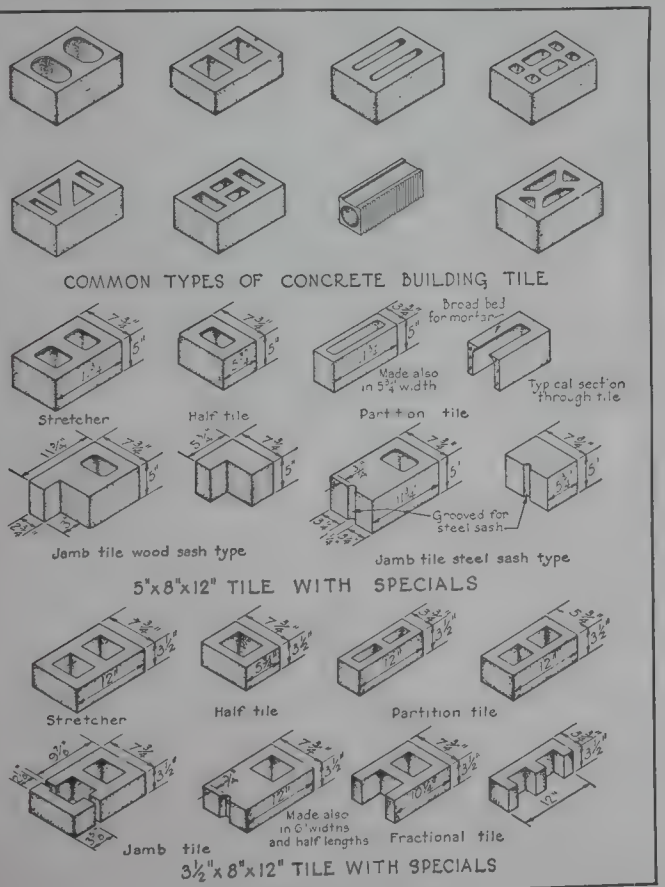
The preponderance of cement block output today is in flat faced units of moderately rough texture, used for foundations and also in the upper walls of buildings up to perhaps four stories in height. The uniformly rough,

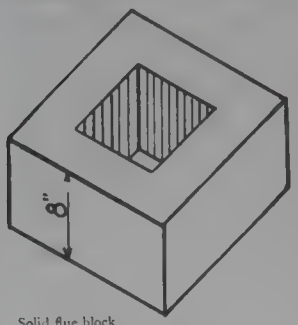


ALPHA CEMENT — HOW TO USE IT

flat texture forms a perfect surface for the application of cement plaster below grade and artistic cement stucco for the upper walls. As the block furnished for a given piece of work are usually all made from the same material using the same mixture, walls laid up with them will be found remarkably uniform in absorption and texture. Uniform absorption guarantees uniform suction for the stucco; uniformly rough texture provides the best kind of mechanical bond and ease of laying in a true plane makes it possible to obtain a first class stucco job with minimum amount of material and labor.

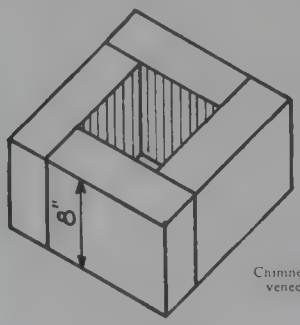
Cement blocks usually contain air spaces equal to one-fourth to one-half of their gross volume, which lightens construction (still retaining amply sufficient strength) and provides better insulation against passage of heat and cold. Cement building tile have air spaces occupying from one-half to three-quarters of their gross volume, giving a lighter weight unit for relatively low bearing walls as well as partitions and other non-





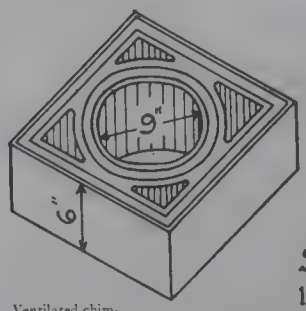
Solid flue block

Sizes
16"x16"
18"x18"
20"x20"
24"x24"



Chimney construction of veneer or joist block

Sizes
16"x16"
20"x20"



Ventilated chimney block

Sizes
16"x16"
18"x18"

bearing construction, "back-up" for face brick masonry and similar uses. The tile is usually made of relatively stronger concrete, so that it will support the same load per unit of gross area as does the block.

The prevailing size of block has a face 16 inches long and 8 inches high (less ¼-inch to ⅜-inch for mortar joint) and is made in thicknesses of 8, 10 and 12 inches to provide the wall thicknesses usually required by building regulations. One popular size of building tile has a full width of 8 inches, full length of 12 inches and is 5 inches high, with a tolerance of 3 percent. Both of these sizes will be found convenient where desired to use in connection with brick masonry. A number of other sizes are also in general use. On pages 38 and 39 different types of cement block and cement building tile in common use are shown.

Block for Special Purposes

In addition to the cement blocks and building tile referred to in preceding paragraphs, a variety of similar units—both hollow and solid—are available for many special uses. Silos, water and grain tanks and coal pockets are frequently made of hollow block 8 inches thick, made to fit into circumferences of sizes desired. Cisterns and catch basins are commonly made of tongue-and-grooved or interlocking block, made solid, with a thickness of 4 inches to 6 inches. Millions of these block are used each year for manholes, catch basins and conduit outlets in the larger cities. These block, or large diameter cement drain tile are frequently used for well linings and probably provide the best and most economical method in almost all cases.

Several types of cement chimney block are being successfully used both in the cities and in rural districts. See types shown on this page. For small and moderate size dwellings, private garages and small miscellaneous structures, well made chimney block, laid in a mortar made of 1 part cement to 3 parts sand, with flush joints, will be found equally as safe as unlined brick chimneys with walls 8 inches thick. The use of flue lining is commonly recommended or required by the building departments for chimneys of all masonry materials. Flue lining adds little to the cost of the chimney and provides safety against fire even if the construction of the chimney should be slighted in some way or the flue be subjected to most intense heat.

Manufacturing Methods

Cement block and building tile as well as most other cement products, are usually

manufactured better by machine than by hand. Block making machinery providing iron or steel mold boxes into which the concrete is compacted by hand are inferior to the larger and heavier molding machines above which are mechanically driven tampers. Power tampers operate uniformly all day long—producing products at 5 o'clock in the afternoon which are just as well compacted as those made at 8 o'clock in the morning. This is not always the result where the tamping is in the hands of the workmen. Heavy rigid machinery reduces the vibration to which the product is subjected in manufacture, thereby eliminating any chance of cracking from this cause.

In addition to the "tamping" type of equipment for making cement building products there is also the "pressure" process, the concrete being compacted by means of direct and increasing pressure; the products being "squeezed" instead of "tamped." Cement block and building tile are also made quite frequently by the wet casting process, in which rather wet concrete is run into "gang" molds preferably arranged on a car standing on a vibrating platform located directly before the mixer. The wetness of the mix, as well as the vibration serves to compact the mass. If the amount of water used is held to the minimum necessary for good edges, products of excellent quality are made.

Mixtures suggested for the manufacture of cement block and building tile, contained in the table on page 12, are given only as approximate. Where more scientific methods are not available, follow this procedure: Accept, for example, a 1:2½:4 mixture, the 2½ parts being well graded sand (up to ¼ inch) and the 4 parts being pebbles ranging in size from ¼ inch to ½ inch.

1. If this mixture gives very smooth surfaces it may be assumed that less sand can be employed. Then either reduce proportion of sand (if compression tests in a good laboratory show the block not overly strong) or increase the proportion of the larger material, if block have been giving somewhat greater strength than required. Continue to reduce sand or add pebbles or stone as long as acceptably smooth surfaces and sharp corners are obtained.

2. Use as much water as possible within operating limits of tamping or pressure type machines; use as little water as possible if employing a wet molding system.

Laying foundation and walls of cement tile. No forms required. Insulation is thus ideally provided for

3. Coarser grading always increases strength as long as there is satisfactory workability. Finer material in the mix makes surfaces smoother and corners sharper.

4. The use of more cement in the mixture always increases strength.

5. If block are to be used as a base for stucco or a cement plaster coat, a uniformly coarse texture, created by using a coarse grading of material is desirable, although even quite smooth untrowelled surfaces of block afford ample bond for coatings.

Most cement block are manufactured today in commercial cement products plants many of which have a large annual output—some of them a million block or more. Factory-made block and tile are superior to home made units because of greater uniformity and other qualities acquired through the use of large equipment, uniform operation and adequate curing. Curing is discussed in considerable detail on page 22.

Cinder Cement Blocks

In many localities building block made of cinder concrete are being offered for foundation, bearing wall and partition purposes. While these block are made to meet strength requirements of the standard product, they are approximately 30 per cent lighter and may be nailed into. The latter feature is an obvious convenience in attaching door and window frames, scaffolding and interior fittings. The manufacture of cinder cement blocks, which is involved in certain patents, should be undertaken only by regularly equipped cement products factories provided with properly prepared cinders of dependable quality.

Laying Cement Block and Cement Building Tile

Mortar. It is recommended that portland cement mortar be used for laying concrete building units because of its great bonding power, compressive strength, density and resistance to weather. Cement mortar should be made with clean graded sand and clean water. Well slaked or commercially hydrated lime is usually added to make mortar more plastic or "fat." For ordinary work a mortar composed of one part portland cement, one part lime and not more than six parts of sand (measured by bulk) is considered satisfactory. When mortar of maximum strength is desired or if mortar is to be used in laying fine face block, the amount of lime used should be limited to about 10 pounds of lime to each sack of cement.

Mortars may be colored where desired, following the directions given on page 52. In laying block and building tile plenty of mortar should be used and spread so as to produce a perfect bed. To produce a two-wall structure with unbroken insulating air space, the building units should be laid without continuous cross joints—no through mortar joints.

Wall details. In building with cement block or tile, construction may be simplified by holding as far as possible to horizontal dimensions which will require only whole and half length units. This practice avoids cutting block or fitting in fractional sizes. In the same way, window and door frames should exactly fit an even number of course heights. Thus, if the courses are of blocks which lay with a height of 8 inches in the wall, openings 6 feet, 5 feet 4 inches, or 4 feet 8 inches in height, with 5 or 6 inch sill, fit exactly. Commercial manufacturers of cement products supply "jamb" block to fit all ordinary designs, which aid greatly in securing weathertight connections around all openings.

Lintels and Sills. Lintels are usually pre-cast, that is, molded previously to being set. Simple wooden molds are usually employed for this purpose, the sides being bolted or clamped together so that they may be easily taken apart in order to remove the lintel (usually in 24 hours) without fear of damage. It is convenient to make lintels the same height as the block courses, and their length should be such that each lintel will exactly displace whole and half wall blocks. Where the openings are wider than 3 feet, the lintels must be reinforced. The steel rods used for this purpose are placed one inch above the bottom of the lintel. Two half-inch rods, symmetrically spaced, are used for lintels with clear span from 3 feet to 5 feet. Lintels must always be so marked on leaving the mold that there will be no difficulty in distinguishing top and bottom. Should a lintel be placed in masonry upside down, the rods would not serve any purpose, or should it be placed on its side, only one rod would be placed to take care of the load.

Window sills are usually of the "slip" type, which are cast in advance but set in the openings, and not so placed that they carry any of the weight of the masonry above.

Cement Brick. Cement brick are made in practically the same way as cement block. In size they conform to the established dimensions for clay brick for convenience in interchanging or joining walls of the two kinds where necessary. A 1:5 mixture of cement and aggregate is commonly used, in which the 5 parts represent about 60 per cent sand and 40 per cent pebbles or stone ranging in size from ¼-inch to ½-inch. In some systems of manufacture a small amount of aggregate up to 1 inch in size can be used. This practice makes for economy of manufacture and for strength, but may add to difficulty of cutting the brick, which in some cases is an important consideration. It is a good rule in brick manufacture to use as much coarse material (all above ¼-inch) as can be carried in the mixture without causing excessive roughness of texture and breaking of the corners.

Cement face brick of high quality are now offered for sale in many localities, usually including a splendid variety of colors and textures, some of which, such as greens, blues and variegated shades in stippled, smooth or wire cut surfaces, cannot be obtained in the clay product. Cement face brick now have a large sale for fireplaces and ornamental interior trim as well as for the usual exterior purposes.

The process of producing the colored facings for cement face brick varies considerably with the type of manufacturing equipment employed. Directions for coloring mortar are given on page 52.

Data on Various Concrete Masonry Walls per 100 Square Feet of Wall Area

Concrete Block

DESCRIPTION		Wall Thickness	Weight Per Unit (Lb.)	Number of Units (Per 100 square feet of wall area)	*Mortar (Cubic Feet)	Weight Lb. (Per 100 square feet of wall area)
8″ x 8″ x 16″		8″	50	110	3.25	5850
8″ x 8″ x 12″		8″	38	146	3.50	6000
8″ x 12″ x 16″		12″	85	110	3.25	9700
8″ x 3″ x 16″		3″	20	110	2.75	2600
9″ x 3″ x 18″		3″	26	87	2.50	2500
12″ x 3″ x 12″	Hollow	3″	23	100	2.50	2550
8″ x 3″ x 12″	Partition	3″	15	146	3.50	2550
8″ x 4″ x 16″	Block	4″	28	110	3.25	3450
9″ x 4″ x 18″		4″	35	87	3.25	3350
12″ x 4″ x 12″		4″	31	100	3.25	3450
8″ x 4″ x 12″		4″	21	146	4.00	3500
8″ x 6″ x 16″		6″	42	110	3.25	5000

Concrete Tile

5″ x 8″ x 12″	8″	19.9	220	5.00	4900
5″ x 4″ x 12″	4″	9.9	220	5.00	2700
5″ x 6″ x 12″	6″	14.9	220	4.00	3800
3½″ x 8″ x 12″	8″	16.5	300	6.00	5550
3½″ x 4″ x 12″	4″	8.5	300	5.00	3050
3½″ x 6″ x 12″	6″	12.5	300	5.50	4300

Light Weight Concrete Block

8″ x 8″ x 16″	8″	27-32	110	3.25	3300-3850
8″ x 8″ x 12″	8″	21-24	146	3.50	3400-3850
8″ x 12″ x 16″	12″	46-54	110	3.25	5400-6300
8″ x 3″ x 16″	3″	11-13	110	2.75	1500-1700
9″ x 3″ x 18″	3″	14-17	87	2.50	1450-1700
12″ x 3″ x 12″	3″	12-15	100	2.50	1450-1750
8″ x 3″ x 12″	3″	8-10	146	3.50	1500-1800
8″ x 4″ x 16″	4″	15-18	110	3.25	2000-2350
9″ x 4″ x 18″	4″	19-22	87	3.25	2000-2250
12″ x 4″ x 12″	4″	17-20	100	3.25	2050-2350
8″ x 4″ x 12″	4″	11-13	146	4.00	2000-2300
8″ x 6″ x 16″	6″	23-27	110	3.25	2900-3300

Light Weight Concrete Tile

5″ x 8″ x 12″	8″	10.8-12.7	220	5.00	2900-3300
5″ x 4″ x 12″	4″	5.4- 6.3	220	5.00	1700-1950
5″ x 6″ x 12″	6″	8.1- 9.5	220	4.00	2200-2500
3½″ x 8″ x 12″	8″	8.9-10.6	300	6.00	3300-3800
3½″ x 4″ x 12″	4″	4.6- 5.4	300	5.50	2000-2200
3½″ x 6″ x 12″	6″	6.8- 8.0	300	5.50	2600-3000

Concrete Brick

2¼″ x 3¾″ x 8″	8″	5.0	1800	18.10	8330

*These figures are based on ⅜-inch mortar joints, 25% wastage included. Weight of mortar assumed at 103 pounds per cubic foot. For ½-inch mortar joints, use one-fourth more mortar than specified in the table.

built close together and a large population occupies a small area. It is likewise of growing importance on the farm and in rural neighborhoods due to the greater use of gasoline and other oil fuels, electric lighting, inadequate facilities for fighting fire and similar considerations. Today the prospective home owner usually can get reasonably fireproof construction without additional cost by selecting cement masonry; the small difference between permanent and ordinary construction seldom exceeds the cost of a season's painting and repair bills on the latter.

The cross-sectional view on page 47 showing cement masonry house construction indicates several of the many superior features. Foundations or cellar walls are so well constructed that they will always keep out moisture and will not sweat; there can be no settlement cracks or movement likely to affect the walls above. Floor loads are perfectly carried and floors cannot sag. Where wooden floors are used the supporting joists are not only seated on an immovable bearing—they are held rigidly within tightly fitting cement joist block, greatly increasing the rigidity of the floors. There is no sagging to cement lintels and no rotting to cement sills, nor can wind or rain enter around door or window frames. The roof, whether covered with cement roofing tile or cement-asbestos shingles, is designed to give dry covering and to continue serving usefully for a life time or more without necessity for repairs or attention of any sort.

Cement masonry houses have proven delightfully comfortable under the greatest extremes of climatic conditions. In the rebuilding of Halifax after the great munitions explosion during the war, cement masonry was used almost exclusively for hundreds of dwellings and scores of commercial buildings. Hundreds of houses, and many stores and mills were built likewise in the suburb of Morgan Park, Duluth, Minnesota, in a part of the country known for its rigorous winters. Utilizing the experience of the Mexican Indians in building thick-walled huts of adobe to protect them from the heat of the day and the cool of the nights, home lovers of the fashionable southern California

The bungalow, although unpretentious, may have lasting charm and character if built of cement masonry

Stately town houses not only attain superior elegance when of cement masonry, but upkeep expense is reduced to a minimum

Fire Losses

National fire losses have increased every year.

Actual insurance paid exceeds 500 million dollars yearly. Actual loss is considerably more.

Present fire loss exceeds $16 per second, or $60,000 per hour, day and night.

The yearly fire loss equals 1000 tons of gold, equalling twice the interest on all saving accounts and would build 100,000 houses costing $5,000 each.

Forty-one persons are burned to death and 47 persons are seriously injured by fire every 24 hours—15,000 people per year are burned to death!

Fire Frequency

1 Dwelling fire every 3 minutes.
1 Farm building fire every 7 minutes.
15 Hotel fires every day.
5 School house fires every day.
5 Church fires every day.
1 Hospital fire every day.

Cement Masonry is Fireproof!

ALPHA CEMENT — HOW TO USE IT

communities are rapidly giving preference to cement masonry over all other types. The remarkable suburbs of southern Florida —Coral Gables, Hialeah, Hollywood, Cocoanut Grove and others, are being built up mainly of cement masonry—proof that this type has proven beyond question its ability to cope successfully with the Florida climate.

Cement masonry houses are permanently beautiful—in fact more beautiful with age—because they are surfaced with artistic cement stucco applied so that it becomes a part of the cement walls themselves. The surfaces of no two cement masonry houses need be entirely alike as to color or textural treatment. The artistry of hand application —producing individual effects in the play of light and shadow—so that every house is different but harmonious, is responsible for the entire absence of monotony even where there are many cement masonry houses side by side.

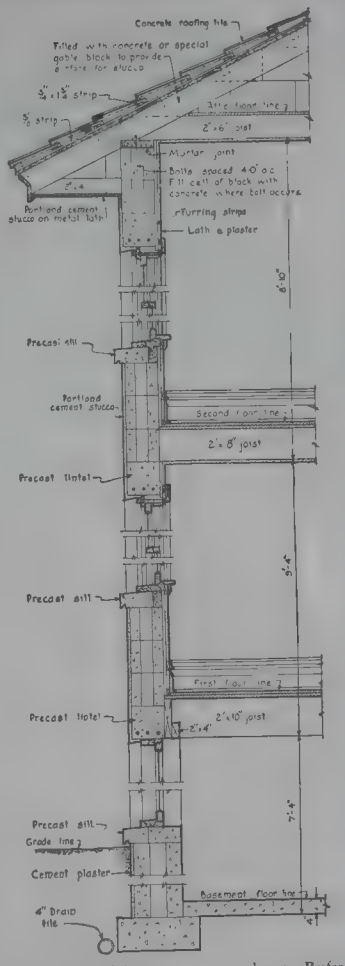
Time merely weathers this beautiful treatment, mellowing and softening it with age. In it is contained the secret of the charm of old country homes, gaining in dignity and beauty as the years roll on. Happily enough, the magic of this treatment may be applied to any style of architecture—with the assurance of pleasing results.

How the House is Constructed. It rarely pays an owner to attempt to build his own house unless particularly well fitted for the task by previous experience. Likewise, it seldom pays an owner to make his own cement block if this material is obtainable from a manufacturer. Every owner should know how his house should be built.

The walls of the house are built entirely of plain cement block (or tile) laid in cement mortar and covered with cement stucco.

Extreme care is taken when the first course of block is laid on the footing to get it exactly level. Succeeding courses are then laid rapidly until the eave line is reached, interrupted only to set in floor joists, window and door frames.

Standard quality cement block or tile should be used. Since the inside of all main walls is to be furred, lathed and plastered, provision must be made for conveniently attaching the furring strips. This is usually accomplished by embedding in the mortar joints small wooden strips, frequently portions of lath 1½ to 2 inches in length, at intervals of every 3 courses vertically; horizontally they are placed to accommodate the strips, usually 16 inches apart. Wood strips or metal devices for the same purpose should be inserted similarly for attaching wooden interior trim.



Sectional drawing of the cement masonry house. Perfection of design is revealed in every detail

There is no monotony when cement masonry houses are built side by side. The house in the foreground has a veneer of face brick on the lower story

Galvanized or painted metal lath is preferred for all partition walls, ceilings and area under the eaves, on account of rigidity and superior protection offered against fire. Basement partitions should always be of cement masonry, producing fireproof enclosures, keeping steam and moisture in the laundry (if located in the basement), retaining dust and smoke in the furnace room and providing a rigid floor support.

Cement steps and porches are used so commonly that they are not now thought of as exclusive features of the cement masonry house. Nevertheless, good steps and porches are so important that this part of the building has received special consideration in cement masonry house designs. Cement steps should have surfaces produced by trowelling with a small wooden float; they should be smooth enough to be easily kept clean and still sufficiently gritty to hold the foot firmly to the tread and prevent slipping. The light gray color of cement steps makes them less difficult to see in the dark; they are, of course, entirely immune to rot and decay and the wear is almost nothing.

Cement masonry houses are being designed by the leading residence architects—in many cases even for the architect's own occupancy.

It is noteworthy that cement masonry is the choice where nothing short of the best will do, and as often where limited funds sharply restrict the selection of materials to the least expensive.

Concrete Floors for Residences

The permanence and firesafety afforded by reinforced concrete first floors in residences appeal to the home owners.

Lack of rigidity in floors with consequent sagging or other movement is responsible for most plaster cracks in dwellings. Likewise, floors that are subject to movement are responsible for doors and windows being out of plumb, cracks in wood flooring, and countless other structural defects that are commonly found in the average house. Concrete residence floors are free from sagging, deflection or lateral movement and eliminate plaster cracking on walls and ceilings and minimize redecorating costs. Concrete floors reduce vibration caused by heavy city traffic or by movement within the residence. Concrete floors do not decay; their strength and durability increase with age.

Incombustible floors prevent the spread of fire from one story to another and confine a fire to its place of origin. Builders find that they can construct rigid, durable, firesafe concrete floors at a comparatively small additional cost over ordinary construction.

The three types of reinforced concrete residence floors now in general use are solid slab, tile and joist, and ribbed. These three types described in detail, with drawings showing typical designs, construction methods, etc., are given in our literature on floor construction, which is free upon request.

ALPHA CEMENT — HOW TO USE IT

Portland Cement Stucco

Portland cement stucco is a mixture of Portland cement, sand and water, often with a small amount of hydrated lime, the latter merely added because it helps to make the mixture "fatter" and in that respect easier to apply. Stucco finishes enjoy wonderful and growing popularity because of the almost infinite variety of individual effects obtainable by the use of colored sands and pigments and through ingenious variation in the methods of application. The illustrations on page 51 are merely typical of hundreds of beautiful surfaces which may be obtained. The textures are more fully shown in special literature on cement stucco furnished by us upon request.

Stucco, used as an "overcoating" for old frame buildings, gives them a large measure of protection against fire from without and preserves them against such enemies as rot, decay and corrosion. It cuts maintenance expense such as painting and repairs, makes the building warmer in winter and cooler in summer and if the job is well planned and handled it adds greatly to the appearance of the structure. General suggestions for the use of stucco on wooden buildings, old or new, are contained in the following paragraphs, in addition to which readers are invited to request more complete information on the subject contained in our free literature on the application of Portland cement stucco.

In placing stucco on a frame structure a supporting frame of furring and lath is necessary. The method in most common use is to apply 1 x 2 inch furring strips, vertically, over sheathing paper, at intervals of 12 inches. Preferably galvanized or painted metal lath (weighing at least 3.4 pounds per square yard) is then attached. Wire lath not lighter than 19-gauge, 2½ meshes per inch, with stiffeners 8 inches apart may be used. In stuccoing the surface of an old frame building it is usually desirable to leave the old weatherboarding in place, bringing out window and door trim so that they will project slightly beyond the surface of the finished wall.

Although two-coat work usually may be used on concrete masonry with entire satisfaction, three coats are necessary for all stucco applied to metal lath.

Applying Stucco to Concrete and Other Masonry Surfaces

"Masonry walls were found to make the best bases for stucco," says a recent bulletin by the U. S. Bureau of Standards, "and on such walls the finest stucco textures can safely be used." Cement block or cement tile walls make the finest base for stucco because they not only provide perfect rigidity, but they produce a wall surface with adequate and uniform suction and mechanical bond, requiring a minimum amount of stucco material to produce satisfactory work.

Cement masonry walls (and those of poured-in-place cement work as well) must be of coarse texture, clean and moist, but not weak or friable. There must be no substance such as paint or dirt on the surface. Two or three coats are usually applied in the process—the first and intermediate coats (if any) being given sufficient body to bring the surface to the plane desired. The finish coat may be quite thin, its function being merely to provide attractive surface treatment. Under coats are usually ⅜-inch to a ½-inch thick. The finish coat varies, but usually need not be over ¼-inch thick.

The stucco mixture should contain 1 part of Portland cement to 3 parts of suitable plaster sand, to which may be added commercially hydrated or well slaked lime not to exceed ten pounds per sack of cement. A greater proportion of cement will make the stucco more susceptible to hair checking, while a lesser proportion may produce a mixture not sufficiently watertight. Just sufficient water should be used to give the mixture a good workable consistency. The less water used the better the quality of the mortar, within the limits of workable consistency.

The plastering should be carried on continuously in one general direction without allowing the stucco material to dry on the working edges. If impossible to cover the full width of the wall at one operation the joining should be done at some natural division of the surface. The first coat must cover the base thoroughly, the material being pressed in somewhat to insure a good bond. After it has hardened partially the surface is cross-scratched with a saw-tooth scratcher to provide keyways for bonding the next coat.

Applying the final coat of Portland Cement Stucco

Allow the first coat to become thoroughly dry. It shall be wet down but not saturated with water before applying the second coat. The second, or browning coat, shall be at least one-half inch thick over the face of the first coat and shall be rodded straight and true in every direction, or left untrue giving a wavy effect, as the desired finish would suggest. If the finish is to be a float type finish, the second coat shall be brought to a good even surface with wood floats. This coat shall be wet down for at least three days and allowed to become thoroughly dry before the finish coat is applied.

The final coat is put on solely for decorative effect. The materials are prepared in the same manner as for the under coats with the exception that marble chips, mica spar or specially prepared sand often replace the plaster sand as aggregate. Mineral pigments are also added occasionally in order to impart tints, which add decorative value and if properly mixed may be considered permanent. Deep or vivid shades are not recommended. They are seldom pleasing to begin with, and usually may be expected to weather or fade somewhat. All color mixtures should be mixed according to the directions contained on page 52.

The Portland Cement Association's literature on Portland cement stucco describes some of the more important stucco surface treatments as follows:

Sand Floated

The finishing coat, after being brought to a smooth, even surface, should be rubbed with a circular motion of a wood float with the addition of a little sand to slightly roughen the surface. This floating should be done when the mortar has partly hardened.

Rough Cast or Spatter Dash

After the finishing coat has been brought to a smooth, even surface with a wooden float and before finally hardened, it should be uniformly coated with a mixture of 1 sack of cement to 3 cu. ft. of fine aggregate thrown forcibly against it to produce a rough surface of uniform texture when viewed from a distance of 20 feet. Special care should be taken to prevent the rapid drying out of this finish by thorough wetting down at intervals after stucco has hardened sufficiently to prevent injury.

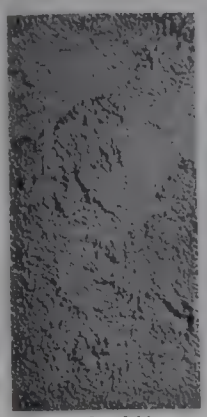
Applied Aggregate

After the finishing coat has been brought to a smooth, even surface, and before it has begun to harden, clean round pebbles, or other material as selected, not smaller than ¼ in. or larger than ¾ in. and previously wetted, should be thrown forcibly against the wall so as to embed themselves in the fresh mortar. They should be distributed uniformly over the mortar with a clean wood trowel, but no rubbing of the surface should be done after the pebbles are embedded.

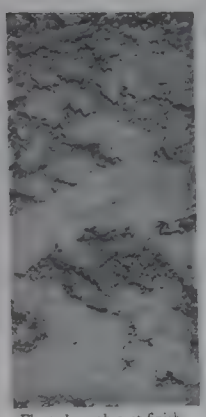
Exposed Aggregate

The finishing coat should be composed of an approved, selected coarse sand, crushed marble, or granite or other special material, in the proportion given for finishing coats, and within 24 hours after being applied and troweled to an even surface should be scrubbed with a stiff brush and water. In case the stucco is too hard, a solution of 1 part hydrochloric acid in 4 parts of water by volume can be used in place of water. After the aggregate particles have been uniformly exposed by scrubbing, particular care should be taken to remove all traces of the acid by thorough spraying with water from a hose.

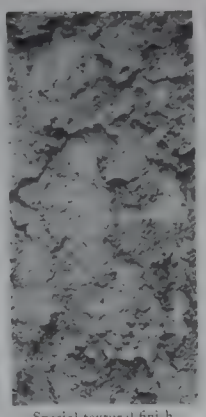
ALPHA CEMENT — HOW TO USE IT



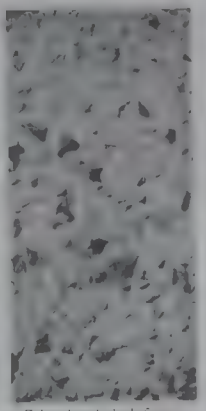
Torn float finish



Floated rough cast finish



Special textural finish



Colored rock dash finish

Important Points in Use of Portland Cement Stucco

Workmen

Trust important stucco work only to experienced workmen.

Design

Stucco should be used only on vertical or inclined surfaces where water will drain.

Keep stucco above grade line by running it to a 6 or 8-inch belt course at grade.

The overhang of all belt courses, water tables, sills, and other projections should have drips and steep washes.

Materials

Use only clean, properly graded sand, not more than 5 per cent of which should pass a 100 mesh screen.

Mixing

Measure proportions accurately and stick to them. Use the same proportions for all batches of one coat. Richer mixtures may craze. Lean mixtures will be porous.

Mix sand and cement thoroughly in a mortar mixing machine for two minutes while dry, then for two minutes after water is added.

Use only enough water to produce a plastic mortar that works easily.

Hydrated lime, when used to increase plasticity, may be added dry in quantities up to 9 lbs. to one sack of cement.

Mix only batches that can be applied within 30 minutes.

Placing

Moisten the masonry and concrete block walls and each coat of stucco before applying the succeeding coat.

Apply the stucco continuously in one direction, and do not let the edges dry up.

Work stucco coats only to an extent that is absolutely necessary.

Keep mortar coats wet for several days. Apply water as soon as each coat has hardened enough so that it will not wash.

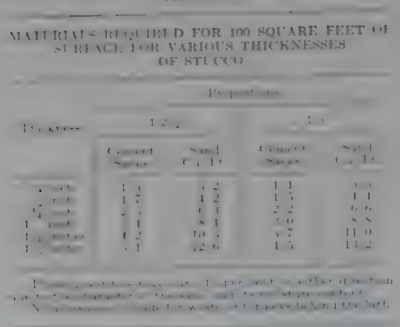
Finishing

Apply the finish coat only after previous coats have been cured for at least one week.

Use only wood float to prepare the finish coat for final surface finish.

TABLE 8

MATERIALS REQUIRED FOR 100 SQUARE FEET OF SURFACE FOR VARIOUS THICKNESSES OF STUCCO



Protection Against Drying Out

Because of the exposed positions in which stucco is almost invariably placed, careful attention should be given to insure against rapid drying out with consequent loss of strength. The surface should be kept moist by sprinkling as soon as hard enough to permit such treatment without damage. If exposed to sun, wind or frost, it may be necessary to protect the surfaces with tarpaulins or other suitable coverings for the first two days. A popular method of preventing rapid drying is by covering the surfaces with burlap which is kept saturated with water.

Color Tints for Cement Surfaces

The use of colored sands, or crushed rock offers the best means for obtaining dependable color tints in the surfaces of stucco, mortar, cement products and floors. Where aggregates cannot readily be obtained for the desired shades, first quality mineral pigments may be employed, but organic coloring materials should not be used

Interesting example of tinted Portland cement stucco

Owing to unavoidable variations in the color of the cement and aggregates, it is impossible to accurately specify by formula the quantities of pigments required to produce certain desired shades. The most satisfactory procedure is to select from the following list the mineral pigment required, then making up small sample panels of the same materials and proportions intended for use in the work at hand. An accurate record is kept of the amount of coloring, cement and aggregate in each trial batch, by weight, so that these proportions may be easily duplicated later. The trial panels are kept moist for 4 or 5 days, then avoiding direct sunlight until quite hard. When fully cured and entirely dry the colors will appear lighter than when wet.

In structural concrete the proportion of pigments to cement is limited to about 10 per cent by weight (9 pounds of color per sack of cement) as greater quantities of color may interfere with the resulting strength. For facings, and the surface coat of stucco, somewhat greater proportions of pigments than above stated are frequently used, without harmful results.

In any mixture containing pigments the mixing must be very thoroughly done in order to perfectly incorporate the color. The cement and pigment are sometimes thoroughly mixed together dry, then added to the mortar mixture in the same manner as the cement is customarily added.

RECOMMENDED COLORING MATERIALS

Color Desired	Pigment
Blue—Various shades from light to bright	Prussian Blue or Ultramarine Blue
Brown shades	Burnt Umber or Brown Oxide of Iron
Buff	Yellow Ocher or Buff Oxide of Iron
Grays and Slate Shades	Manganese Black or Germantown Lamp Black
Greens	Greenish Blue Ultramarine Chromium Oxide Mixture of Yellow Ocher and Ultramarine Blue
Red, Pink, Terra Cotta and similar shades	Red Oxide of Iron

For extremely pale tints, such as cream, pure white sand should be used; for absolute white, use white Portland cement and white sand.

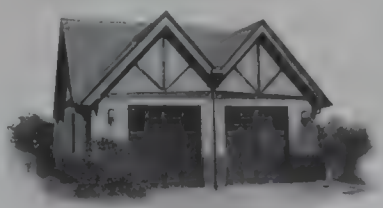
Building a Cement Garage

The garage on the home premises should not only give the owner maximum value in permanence, fire-safety, low maintenance and general security, but it should also be of pleasing appearance, always in harmony with the surroundings. A garage of cement masonry with walls of cement block covered with cement stucco fulfills all of these requirements at moderate first cost and negligible expense thereafter.

Home owners prefer to have a garage on their own premises for convenience, economy and the opportunity thus provided to work about the car. If built of permanent materials the home garage is usually considered safer so far as fire is concerned. A substantial garage is well worth while for it is stronger and therefore less likely to be broken into than structures of the portable or

ready cut kind. The private garage is usually a worth-while investment from another standpoint as well—it provides storage space for tools, equipment and supplies, enabling the owner to buy the latter in quantities where desirable.

While a great many owners are partial to single car garages or cannot in any way make use of more storage room, double garages have become very popular of late because they can be built for only slightly more than the single structures, returning an income from the rental of the extra space. In built up city districts the same idea is often carried further utilizing unproductive rear space for multiple-car or community garages, which provide convenient storage for renters and are usually profitable to owners. Such garages need not be unattractive if properly planned and built of cement masonry.



One of the first questions which confronts the owner is that of size. Single garages should be at least 10 feet in width and 18 feet in length, but a width of 12 feet and length of 20 to 24 feet is preferable, especially for large cars. For trucks, which often have an extreme body width of 8 to 10 feet the garage should have a width of 15 feet. Double garages usually have a width of 20 or 22 feet. Community garages have stall or compartment widths ranging from 9 feet 6 inches to 15 feet, according to type of storage. If only pleasure cars are to be stored the stall width need never exceed 12 feet. Ample space in the garage costs little and is usually very convenient for storage.

Cement masonry garages are so simple in construction that few directions are re-

AN INEXPENSIVE ONE CAR GARAGE

BILL OF MATERIALS FOR CEMENT WORK

ALPHA Cement	33 barrels
Sand	2.33 cu. yds.
Stone	4.66 cu. yds.
½" reinforcing rods	1500 lin. ft.
¼" reinforcing rods	30 lin. ft.

SIDE ELEVATION

PLAN

AN ATTRACTIVE TYPE OF TWO CAR GARAGE
BILL OF MATERIALS FOR CEMENT WORK
WORK BENCH
SIDE ELEVATION

For ease in entering and leaving, every community garage should be provided with a cement driveway

quired for their successful erection. The footing is built just as for a cement masonry house—except narrower—in an excavation carried below the frost line. Under ordinary soil conditions the footing width need be only 12 inches and the height 8 inches. The block or tile are then laid in a cement mortar bed or footing, carefully leveling and squaring the first course. Subsequent courses, to the eaves, are then quickly laid in the usual manner.

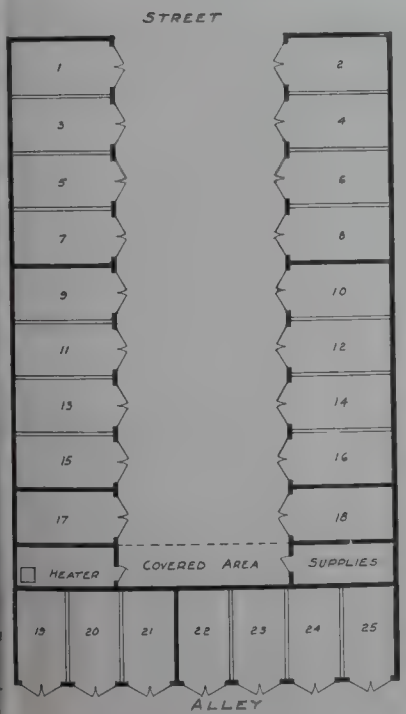
A cement floor is a necessity. It may be constructed to drain to an outlet in the center or at some convenient point within the garage. Some owners prefer to slope the floor toward the large doorway, so that moisture drains directly to the outside. This method eliminates the possibility of escaping gasoline accumulating in sewer traps.

If the garage will house only pleasure cars the concrete floor need only be 3 inches thick; if trucks are to use it, the thickness should be 4 inches. A mixture of 1 part cement to 2 parts sand and 3 parts screened gravel (pebbles) or broken stone may be used for the entire floor thickness, placed at one time. The floor may be laid in one slab covering the entire surface of a one or two car garage, or may be divided into four slabs approximately 10 feet by 10 feet each.

If the ground has been disturbed or a fill made, it is advisable to compact the surface, or even to cover it with a few inches of cinders, which are well compacted, before the floor is laid. The same procedure is even more necessary in the case of the approach slab. This is sloped at an easy angle in order to run off water and to afford smooth passage in and out of the garage. The approach is frequently made by continuing the floor

Community garage with cement masonry walls and cement roof. Fire-resistant and maintenance-free construction

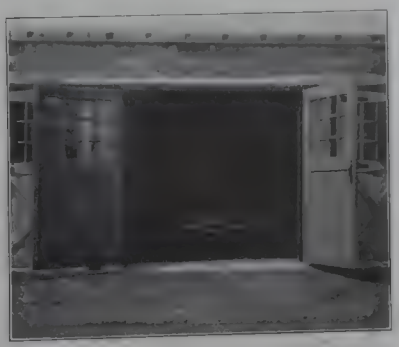
An "Automobile Apartment" is what the community garage really is



Two floor plans for community garages

out beyond the building line, giving it the required pitch. If this practice is followed it is very necessary that adequate drainage be provided by placing a well compacted layer of cinders or gravel, at least 6 inches deep, under the slab.

The garage roof is usually made to conform to the type used on the residence, although not necessarily the case. The most economical satisfactory method of building at the present time is to use cement-asbestos shingles or cement roofing tile over a wood frame, ceiling the under side including eave underhang, by the use of cement plaster applied to metal lath.



An automobile in one of the convenient stalls of a community garage

Economical Community Garages

The community garage is beginning to make a place for itself in the residential sections of our cities. It combines many of the advantages of the individual private garage with those of the public storage. In principle the community garage resembles many single garages placed side by side, with heating arrangements and other facilities in common. It often represents the most economical use of space for automobile storage purposes and in many localities offers an excellent opportunity for investment.

Ready for the stucco coats. Roof of cement roofing tile

To reduce the fire hazard as well as maintenance, the community garage should be built of cement construction. A very large number of structures of this kind have been built recently with walls of concrete masonry construction, using ordinary cement block covered with Portland cement stucco or flat-faced block without stucco. If the garage is well located and some little attention paid to planting vines and shrubs around it, a decidedly attractive appearance is secured, not objectionable in the best communities. If desired, the garage may be entirely concealed.

The views on pages 56 and 57 suggest several good arrangements for garages of this class.

From two to four stalls are usually grouped together in a single compartment, the stalls then being separated by cement block walls to a height of 3 feet, above which are partitions of heavy galvanized wire, extending to the roof. This arrangement is much more economical than earlier types dividing individual stalls with solid masonry walls, still preserving most of the protection benefits and preventing loss of heat throughout the garage should a door be left open in cold weather.

Each stall has its own doors, lights, water closets and bench. The heating pipes are usually carried in a small depression in the floor along the side of the building opposite the doors. A curbing is formed around this depression in the floor to keep out water and dirt. All doors are fitted with individual locks, to which the janitor has a master key. Each stall may be provided with a slate on which the car-owner leaves directions for cleaning or other service desired, and by this method his car is ready for instant use.

A commercial garage of cement masonry, fireproof throughout, attractive and able to cope with the hard usage demanded of structures of this kind

Cement Posts

Fence Posts, Corner Posts, Gate Posts, Inclosure Walls

KEEPING fences in good condition is no easy task where the material in the post needs constant care and repair. Even the best wood posts will burn, rot, get out of line, break under heavy strains, or wash out in a flood.

The cement fence post is everlasting. It keeps in alignment and can resist unusual strains without breaking. In some sections its first cost is no more than for a good wood post, but everywhere cement posts are cheaper in upkeep than wood posts. No repairs, no painting; they grow stronger each year.

In comparing the advantages of cement and wood fence posts, the U. S. Department of Agriculture, in Farmers' Bulletin No. 403, has this to say:

"After three years' service wooden posts possess only from one-third to one-half of their original strength, whereas concrete grows stronger with age and needs no repairs, for neither weather nor fire injures it.

"Cement posts are attractive in appearance because of their uniformity in size and color and, because of the durability, they effect a saving in giving greater life to the fencing material used, so that the permanent value of the property is increased."

Cement fence posts on farm of Haverford College, Haverford, Pa. Made with ALPHA CEMENT

CONSTRUCTION · OF · AND ·

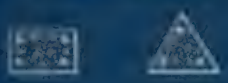
Fig. 1
Gang mold for Concrete fence posts without taper

Fig. 5.
Two methods of attaching wires to concrete fence posts. A hinge may be used to twist wire ties, as shown.

Fig. 6
Forms for corner posts. Post and brace rails are cast in one piece

Fig. 8
Method of bracing fence line every thirty posts. Principle is same as in Fig. 7.

CONCRETE · POSTS · INCLOSURE · WALLS ·



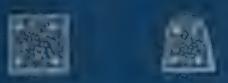
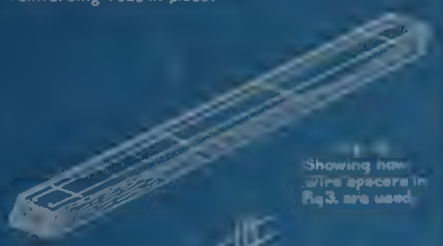


Fig. 2.
Proper position for reinforcing rods in various types of concrete fence posts.

Fig. 3.
Wire spacer used for holding reinforcing rods in place.



Showing how wire spacers in Fig 3. are used.

One method of bracing corner posts. Mortises are cast in corner and brace posts. Concrete brace rails are inserted in mortises as shown.

A common method of spacing and tying forms for concrete walls.

Fig. 10.
The rod and clamp method of holding wall forms in place

ALPHA CEMENT — HOW TO USE IT

Cement corner posts add years to the life of wood fence posts

Cement posts prevent gates from sagging

Molds for Cement Posts

If more than a few posts are required, it will pay to purchase steel molds, which soon pay for themselves in saving of labor, produce better surfaces than home made molds and last a lifetime. In case home made wooden molds are to be used, the rectangular shape will be found easiest and cheapest to produce, making the molds in gangs casting from 4 to 10 posts at a time. For ordinary fencing no post should be smaller than 3 inches square at the top and 4½ inches square at the bottom.

Reinforcing Cement Posts

Since strains on a post may come from any direction, it is necessary to distribute the reinforcing to all sides of the post as indicated on the preceding page. One big rod in the center will not do. The size of rods depends upon the size of the post. Ordinary $\frac{3}{16}$-inch to $\frac{5}{16}$-inch diameter rods will suffice. Wire of proper size may be used but rods are more economical. They must always run the full length of the post, extending as far down in the ground as the post goes. To hold reinforcing rods in place while concrete is being placed, wire spacers are used. These spacers are of No. 16 wire twisted as shown in Fig. 3 on page 61, and used as shown in Fig. 4. Three or four spacers are used to a rod. Note, too, that the ends of rods are turned back about an inch.

Molding Cement Posts

Molds should be treated as suggested on page 26. Concrete for posts should be mixed only in quantities enough for immediate use, following directions on pages 10 to 22.

After the molds are filled to a depth of ¾ inch to 1 inch, two reinforcement rods, properly placed, are laid in. The molds are then filled to within ¾ inch to 1 inch of the top, when the remaining reinforcing is placed. They are then filled to the top.

As soon as the molds are filled, they should be tapped or moved up and down quickly from the corners. This will release the air bubbles and make the concrete more compact.

The exposed corners of the post may be beveled off with an edger and the open face given a smooth finish with a trowel immediately after the surface water has been absorbed and before the concrete has become too hard.

Curing Cement Posts

After being placed, concrete should be left in the mold two or three days to harden. When the end pieces and partitions of the mold are removed, the posts should be left on the bottom board in the shade for a week or ten days, and protected as suggested on page 22. After ten days, posts may be moved outdoors and piled as wood posts are piled. They should be handled with great care, as a slight drop may break a fresh post. Jarring may cause cracks, invisible at first, but seriously weakening.

Cement posts may be used when thirty days old, but not sooner.

Cement Corner Posts. Corner posts stand heavier strains than line posts, and

should therefore be braced properly. They are generally made from 6-in. x 6-in. to 12-in x 12-in. square without taper. The exact size is determined by particular needs. Reinforcing rods range from $\frac{9}{16}$-inch to 1-inch.

On account of their weight and consequent inconvenience in handling, posts larger than 8 inches square are generally cast in place. A hole dug in the ground is filled to the ground level with concrete. Forms are put in position and filled with concrete. If the ground is not firm, forms should be set below as well as above ground.

In corner posts like that in Fig. 6 on the blueprint, the large base of underground part is built of concrete made with field stones in assorted sizes. Unless corner posts are so massive that they will stand in their own weight, they must be braced. (See Figs. 6, 7 and 8 on the blueprint.) Braces as well as posts, must always be reinforced.

Posts may be made monolithic with braces, or posts may be notched or mortised about 8 inches from the top on the sides where the bracing is necessary. Brace rails are cast in molds. One end of the brace rail is inserted in the notch of the post, and the other end inserted in a similar notch near the bottom of a brace post. (See Fig. 7 on the blueprint.) A brace post is heavier than an ordinary line post.

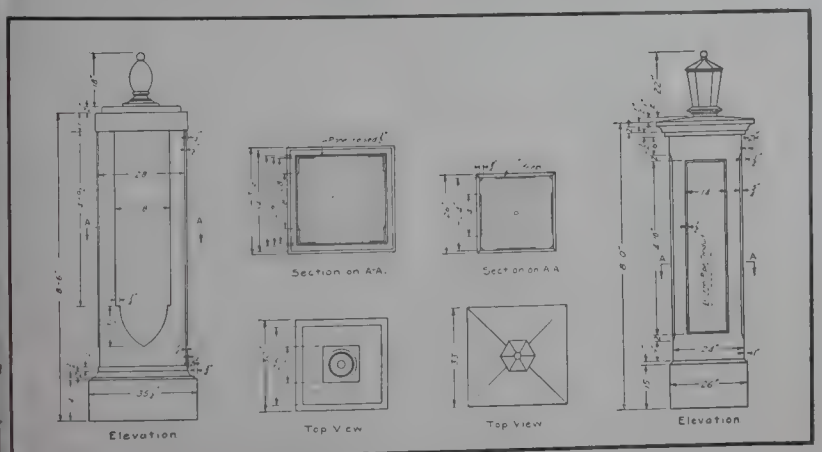
In a fence it is well to brace about every thirtieth post. To do this it is necessary that the thirtieth post, and the post on each side of it, be a little heavier than the rest in order to support the brace rails.

Gate posts and hitching posts are made in the same manner as corner posts. Holes for bolt hinges are sometimes made by inserting a piece of gas pipe in the fresh concrete. Sometimes a hinge with a clamp strap that entirely encircles the post is used. Gate post should be braced unless they are made massive enough to withstand the strains. There is no limit to the many artistic effects possible to secure with concrete in the making of gate posts.

Cement Inclosure Walls

Cement walls are more attractive and more lasting than any other inclosure wall. They need no repairing or painting and are therefore economical.

The principles of construction are very much like those for house walls (see pages 23 to 27). An excavation deep enough to carry the foundation below the frost line is filled with a 6- or 8-inch layer of broken stone, cinders or brickbats, and then filled to the ground level with concrete.



Good designs for cement gate posts. Footings for these posts (omitted from sketch for convenience) are started at a level below frost penetration, same dimensions as at grade

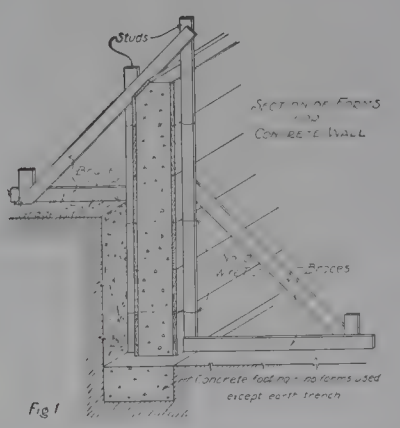


Fig 1

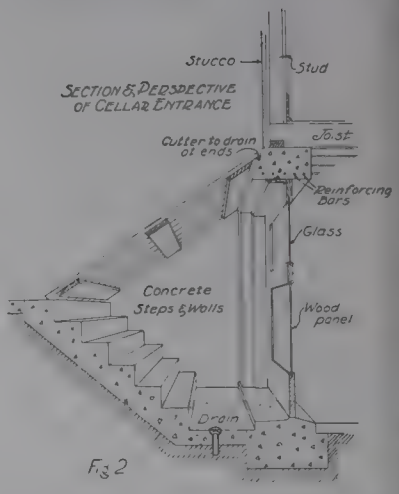


Fig 2

Foundations, Walls and Steps

Fig. 1 illustrates in section and perspective forms for a cement foundation wall. It will be seen that the footing has been placed in the trench without forms and forms for the wall set up on the footing after the concrete has become firm. In order to provide a good bond between footing and the wall proper, it is well to leave the surface of the footing quite rough, in fact better bond can be secured by partly embedding in the upper surface of the footing rough field stones so that when concrete for the wall is placed bond can be secured with these stones. The text in this book under the heading of "Forms and Reinforcement" gives a number of excellent ideas on foundations.

Foundations Under Old Buildings. A complete cement foundation can readily be built under an old building. All that is necessary is to remove from the old wall a few of the stones or bricks as the case may be, at various points around the foundation and insert short pieces of heavy timber to wedge up the building. The building should be carefully raised in this manner entirely clear of the old foundation. Then all of the old foundation should be removed and a trench dug and forms set in place in the usual manner for concreting. In case of small buildings it is usually easy to raise them high enough to allow working room, in which case the forms can be filled right up to the top with concrete. If the building is large and too heavy to be raised readily so as to provide necessary working headroom, the foundations may be made 3 inches wider than the sill. When the forms have been carried to the desired height the concrete may be inserted through this extra space of 3 inches. To make placing of the first layers of concrete easy the top board of the forms may be left off until ready to place the last layer of concrete. The building should not be lowered upon the foundation until the concrete has had at least two weeks to harden. After this time the timbers used for the purpose of wedging up the building may be removed and the openings which they occupied be filled with concrete.

Cellar Steps are shown with construction detail in Fig. 2. While side retaining walls may be built before or after cellar steps are constructed, it will usually be found more convenient to place the forms for the steps after the side walls have been built.

Before laying the concrete for the steps the slope on which they are to rest must be

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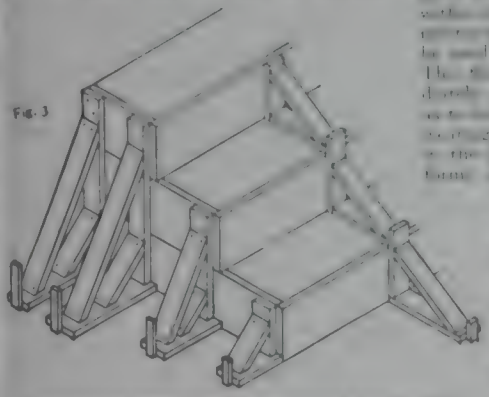


Fig. 3

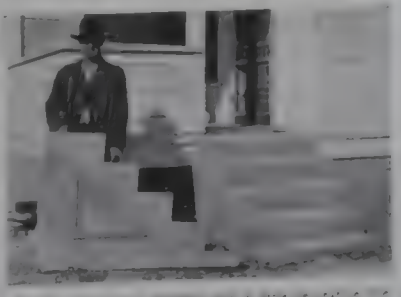
Retaining Wall and Steps

Terraces if too steep, will not stay sodded, and if too flat take up room which would otherwise be a part of the lawn. The neatest way is to place a retaining wall along the terrace edge.

If the wall is over 1 foot high steps are necessary. A most convenient arrangement is to have the bottom step come flush with the face of the wall, making it impossible to fall over one or two projecting steps in the dark.

In building, insert a stop plank between the front and back forms to prevent the concrete from going to the full height of the wall. The bottom of this plank should be kept at a height above the bottom of the wall sufficient to form the first step.

After the concrete for the wall is placed, remove the section of the form where the steps are to come, and dig out the earth to



The entrance of this trim-looking cement storage cellar may be planned by the method shown at top of page 64

Cement Block in Foundations and Walls. For large structures and particularly where it is desired that the foundation or wall be of massive character, no doubt monolithic construction is to be preferred, but for a great deal of foundation work, particularly that type appropriate for dwelling houses and other small buildings, cement block may be and often are used to advantage. Where cement block are available, the labor and expense of setting up and taking down forms is eliminated and the resulting cement work is just as satisfactory in every way as though monolithic cement construction were used. There are ordinarily fewer pockets than in monolithic concrete and presents an attractive appearance.

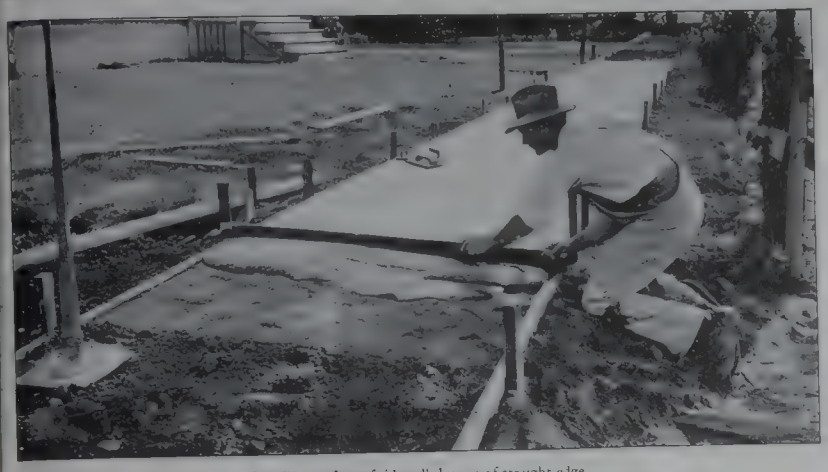
The laying of cement block being essentially masonry work, comparable to the laying of brick and dimension stone, a few precautions different from those one would call attention to in connection with monolithic construction are necessary when cement block are used for building foundations. It is always desirable that basements be dry and there is no reason why basements enclosed by cement block foundation walls cannot be made and kept just as dry as though the enclosure wall were of monolithic construction. All that is usually necessary is to make sure that the block used are of good dense mixture and that they are laid in a rich sand cement mortar not leaner than 1:3, that the block are well wetted before laying and that the mortar joints are completely filled with mortar and well pointed up. As an extra precaution the treatments described on page 36 may be applied.

Walks and Floors

So far as the operations of construction go, there is little difference between cement walks and cement floors laid on the ground. Cement floors such as laid for the various stories of a building above ground level, are necessarily reinforced and, therefore, involve the observance of some principles of construction not associated with similar work supported by soil foundation. The following discussion is not intended to in any way consider the building of reinforced cement floors.

A cement walk is a stretch or strip of concrete intended primarily for pedestrian traffic. It may, however, be compared to any cement pavement. The first essential to success in the building of walks and of floors on soil foundation is that the soil shall be well drained so as to prevent water from being retained beneath, thus preventing an upheaval in freezing weather. The area on which the concrete is to be laid should be cleaned from all vegetation and similar matter, and if the soil is not firm so as to provide a substantial foundation, it should be thoroughly compacted by rolling or tamping so that everywhere bearing power will be equal. All soft and spongy material should be removed and the location refilled with clean gravel containing little or no sand or with hard cinders free from ash. Such filling should then be well compacted. It is desirable, however, to avoid the use of any such filling material where effective drainage in the natural soil can be secured

Good type of barn driveway. By adding side walls and a cement floor an excellent cold-storage room could be had



Leveling surface of sidewalk by use of straight-edge

because the tendency is, when using a subbase of gravel or cinders, to place it in what amounts to a trench and in that way provide a "sink" or sump hole which serves not to drain the foundation but to actually cause water to collect and be retained beneath the finished walk. Therefore, if a subbase of cinders or gravel is used, the added precaution should be taken to lay tile drains to lower outlets at such intervals as will secure free drainage of the subbase.

In order that the surface of a walk or floor may drain quickly after rains, it is necessary that the surface have a slight gradient or slope in one direction or as is sometimes done in the case of a walk, have the surface very slightly crowned. One-quarter of an inch to the foot is sufficient slope to provide for a floor and not to exceed one-quarter inch crown at the center of a walk of usual width (4 feet) will provide all necessary drainage slope for its surface.

Outdoor floors and cement walks may be either of one or two-course construction. One course construction is preferable, especially in the case of feeding floors, barnyard pavements and driveways where greater thickness is necessary to prevent dampness and waste penetration. For such work a 1:2:3 mix is desirable. For ordinary walks around farm buildings, a 1:2½:4 mixture will suffice for one course construction.

Generally, walks in residential sections should not be less than 4 inches in thickness. Walks in business sections, driveways and floors subjected to heavier usage and traffic should never be less than 5 or 6 inches in thickness and where the volume and character of traffic warrant it, be reinforced with wire mesh or bars.

Depending on the thickness of the slab, 2 by 4's or 2 by 6's will serve for forms. These should be held rigidly in place by stakes or braces with top edges true to the line and grade required. Where sidewalks fill the space between curb and building lines, forms should be so set as to give the walk a slope toward the curb of ¼-inch per foot of width. Where walks are bordered by lawns, forms should be set level and drainage of the walk secured by suitable crown at the center. One-quarter inch for each foot from side to center is the maximum necessary. Walks and outdoor floors may be built by so setting forms that alternate slabs are concreted first and when these have sufficiently hardened forms can be removed to permit concreting of intermediate slabs.

Present-day practice in building walks has, however, run toward continuous concreting of the strips and joints are provided for by division plates used where desired to mark the limitation of slabs or by cutting

through the entire thickness after it has sufficiently hardened so each slab may be completely separated from adjoining ones. Where division plates are used, they are usually of ⅛-inch thick steel as wide as the depth of the slab and as long as the width of the walk. They should be thoroughly cleaned and oiled each time before and after use. After the concrete has hardened sufficiently to prevent breaking, the division plate can be removed without difficulty.

Concrete should be mixed to a rather stiff consistency. After being placed between forms it is struck off to the required level by using a template or straight edge. The subgrade where concrete is laid should be dampened just before concrete is placed upon it. If dividing plates are not used to mark the limitations in slabs, every care must be taken to see that in cutting through the concrete to mark a joint it is completely cut through so that slabs are separate. The surface edge of each slab should be rounded to a radius of ¼-inch by using one of the common finishing tools intended for that purpose.

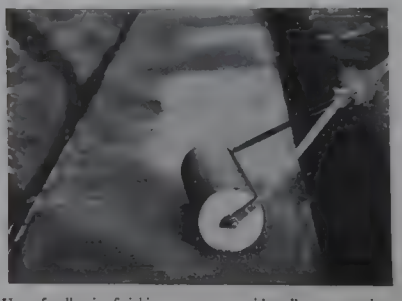
In walks, expansion joints should be used to take care of changing volume of the concrete due to temperature changes. Expansion joints should extend from the surface to the subgrade, be truly at right angles to the sidewalk surface, and be made by putting the specified joint filler in place before placing the concrete. The joint filler used in such cases is generally a premolded asphaltic preparation similar to that used in joints in cement road and street pavements. The expansion joints should be placed at approximately 50-foot intervals and should be about ½ inch thick.

No other detail of cement pavement construction is of more importance than proper curing of the work after actual concreting is finished. In the case of cement walks, however, this precaution for some unaccountable reason is almost universally neglected. As a result sun and wind dry out water from the concrete before that water has had a chance to perform one of its principal objects, namely, the chemical transformation of the cement which results in thorough hardening of the concrete. Specifications for cement highway pavements require that earth or some other moisture-retaining covering be placed on the pavement as soon as possible after finishing and further require that such covering shall be kept in place and moist for varying periods in order to enable the concrete to thoroughly and uniformly harden.

If the construction is to be two-course work, then a base consisting of 4½ inches of 1:3:5 concrete may be used with a ¾-inch finishing coat mixture of a 1:2 cement mortar. It is necessary that the fine aggregate used in the wearing course mixture shall be hard and durable in order to resist the wear of traffic.

In two-course cement walk construction it is important that the top course be placed before the bottom layer has become too dry. When such is the case, the bond between the top and lower course is not established and a separation is effected. Sooner or later, then, the top course becomes heaved or broken.

The latest practice in cement walk construction follows a practice in highway pavement construction: namely, the use of



Use of roller in finishing one-course sidewalk construction

An example of failure to provide for tree growth, resulting in upheaval of slab. A semicircle should have been left in the slab when laid

a light roller to compact the concrete immediately after it has been struck off in the forms and before the final finish is given by a wood hand float or trowel. It is recommended that a roller for this purpose be from 10 to 12 inches in diameter and so built that its weight is approximately one pound per linear inch of surface contact.

Generally speaking, cement walks should consist of slabs not greater than 6 feet long in any dimension. Indoor floors such as those used in barns and stables should be laid in slabs not greater than 10 feet in any one dimension unless the concrete is reinforced.

Finishing. Most walks are now finished with a wood float. The slightly roughened surface obtained by this method insures the greatest safety of foothold under all weather conditions. In some localities the smooth finish secured with a steel trowel is still preferred. Such walks are more easily cleaned of snow during the winter.

After the concrete has been struck off, it is smoothed with the float, leveling off any high spots, filling depressions and working excess water over the side forms. Excessive trowelling tends to bring too much water to the top, forming a chalky surface. Float marks may be removed by brushing the surface with a calcimine brush dipped in water.

Trowelling, a very important operation, deserves full consideration. Excessive trowelling before the concrete stiffens is to be guarded against. Likewise, sloppy consistencies are to be avoided. An excessively wet mix cannot be trowelled without large quantities of fine material being brought to the surface, which will later cause formation of a soft skin or film that will dust. Clay, silt, loam, dust or powdery admixtures should not be permitted in the topping under any circumstance.

After the concrete has stiffened sufficiently steel trowelling will improve the density of the wearing surface. This final trowelling compacts the concrete and provides a tight dense surface.

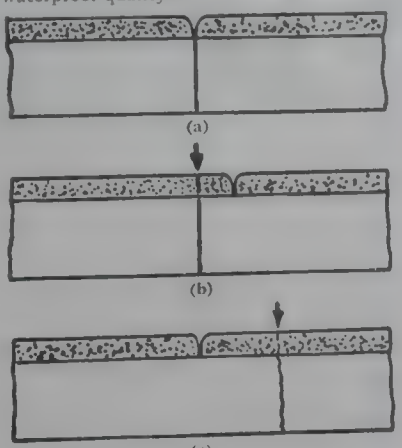
All efforts must be made (1) to place the finish with a low water-cement ratio and yet retain workability; (2) to use clean aggregates; and (3) to delay final steel trowelling as long as possible and yet be able to produce the proper finish.

The strength of the concrete will be materially increased if it is kept moist after hardening has begun. Concrete hardens best in the presence of moisture. Further information on curing is given on the preceding page and on page 22

"Dusting" of Floors. Floors constructed with clean, durable aggregates mixed in proper proportion with cement and water and carefully finished, (avoiding overmanipulation) do not dust. Frequently we hear complaints of cement floors dusting badly. The cause of this has been definitely traced to the use of too fine or dirty sand, soft sand, too lean a mixture, coarse aggregate coated with dust or clay, dirty material of any sort, too much troweling when finishing with a steel trowel, having the cement mixture too dry or too wet and neglecting to protect the work after finished.

Knowing the causes of dusting, the remedy is evident, namely, be sure to avoid those bad practices known to contribute to the undesirable end.

Read the directions in preceding pages of this book covering testing of sand, proper mixing, methods of securing density and waterproof quality.



(a) Sidewalk slab division properly made, through base and top courses.

(b) Where joint in top course is not over joint in base. Result, crack at point indicated by arrow.

(c) No division in base. Result, base may crack, carrying crack through top course, regardless of division in top course, producing crack in top as shown by arrow.

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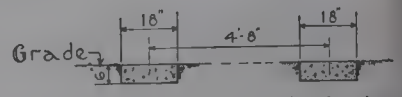
Curbs and Driveways



"Strip drives" are made according to the dimensions shown

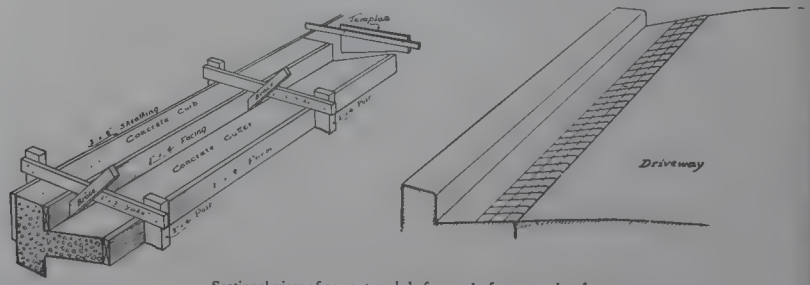
To build a fine cement walk or driveway without protecting the edges with curbing would mean the formation of irregular and disfiguring gutters established by nature, if not the undermining of the structure. The additional expense of adding curbing while the work is under way would represent a small outlay compared with its value. It is a simple matter to construct substantial cement curbing. When properly constructed it will not get out of alignment as is the case with stone curbing. It may be brought to an exact line and finish, thus corresponding in texture and appearance to the pavement it protects. Cement construction is used for this purpose in all large cities and towns, and in response to the great demand for curbing of this character, equipment has been designed to facilitate construction. The same good results, however, may be secured where the work is done by hand. A standard method of constructing ordinary curbing, such as would be suitable for the farm or a suburban property, might be described as follows:

At the edge of the pavement dig a trench at least six inches wide and 18 inches in depth below the pavement surface. The trench should be at least 10 inches wide at the bottom. On the line of the back vertical face of the curb erect forms from the ground line up to a height of six inches above the finished surface of the pavement. Next, place a 2 inch x 4 inch strip along the edge of the pavement. These strips can be held in place by overhanging yokes and braces as shown in the diagram. Concrete is then deposited in the trench and within the forms. The curb is then floated to proper form by the use of a special steel float rounded to a 4 inch radius. The upper outside edge should then be rounded with a ½-inch rounding tool. The type of curb produced is of the rolled face type now coming into popular use and which has many advantages over the straight face or battered face curb. The moment the concrete has sufficiently hardened it should be covered with earth and kept moist for several days or kept wet by other means during the first few days.

Cement Driveways

The cement driveway is reasonable in first cost, and if well built, will last indefinitely. Even on highways subject to constant traffic of all descriptions, cement has proved to be more satisfactory than any other material of like cost. For example, a cement road put down in Bellefontaine, Ohio, some thirty-five years ago has cost less than $25 per mile per year for maintenance during that long period of time. On a private driveway of concrete up-keep cost is practically negligible. It is in recognition of its durable and economical properties that many owners of large country estates are substituting cement construction for other types of roads.

In building a driveway to a house to provide for private automobile or service



Sectional view of cement curb before and after removing forms

A method of saving concrete in an automobile runway

traffic which is seldom excessive, lay the concrete 6 inches at the sides and 5 inches at the center. This thickness will be amply sufficient for such infrequent traffic. The proportions should be 1:2:4. The concrete should be mixed to a mushy consistency and when in place between side forms, which should be rigidly staked at each side of the road, proper shape should be given to the road by means of a template, a long plank reaching from side form to side form, and cut to the desired crown. After bringing the road to proper contour by the use of the template, the surface should be evened up by lightly troweling with a wooden float. When the concrete is sufficiently hard not to pit, the surface should be sprinkled with water, and when the concrete will stand the weight of a man, it should be covered with about 2 inches of earth, which should be kept wet for at least ten days. No traffic should be allowed upon the drive for seven days. Cut at every 25 or 30 feet what are known as expansion joints. These expansion joints should be filled with asphaltic felt or tar paper. Where the driveway receives very heavy loads, such as hay wagons and large trucks, make the concrete 8 inches at the side and 7 inches at the center, mixed in the proportions of 1:2:3. Otherwise the method of construction is the same as already described, with the exception that the edges of the joints should be protected by special steel plates.

Cement Tracks for Automobiles

In some cases property owners possessed of small lots have adopted a rather ingenious method of making cement roads for automobiles by digging trenches and establishing therein narrow cement tracks as shown in the accompanying illustration. This type of construction is not practicable where vehicles pass each other.

Small Cement Buildings

Strength, permanence and freedom from repairs and constant expense are just as much a part of small cement houses as large ones. Small cement buildings include chicken houses, icehouses, hog houses, machine sheds, smoke houses, garages, dairy buildings and other similar structures.

In a way, all well constructed buildings are built by following certain so-called "specifications," and except as it is necessary to vary certain details of a specification to provide for different foundations so that the weight of different sized buildings will be properly carried by the soil, one broad, general specification can be made to include most, if not all, of the requirements of construction.

Foundations for Small Buildings. The first thing necessary is to excavate foundation trenches below the line of frost penetration and to such a depth that firm soil may be reached, to provide the necessary load-carrying capacity. A foundation so constructed will not be subject to heaving from frost action or settlement due to improper bearing, and, therefore, will not crack. Foundation depth to avoid frost usually may be obtained by inquiry to a local builder or some other person familiar with successful building practice in the neighborhood. All roots, sod and any other refuse material must be removed and any soft or spongy spots must be excavated and holes filled with well compacted gravel, cinders or earth.

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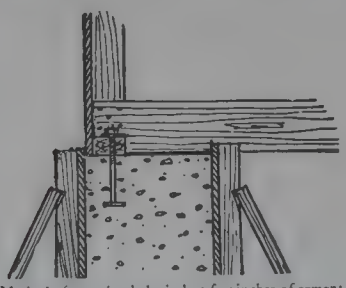
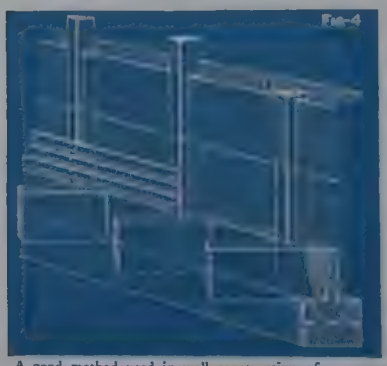


Method of inserting bolts in last few inches of cement foundation so that sills may be secured tightly



A good method used in wall construction of a cement house. The wooden studs are left embedded partly in the concrete. The slight interior projection of the studs makes furring and a dead-air space easily possible

Placing footing and cement block foundation wall

Bearing Area of Soils

The bearing area for different soils is commonly calculated according to the following table, which may be used for foundations, footings, piers, engine bases and similar work:

Soft Clay—1 to 2 tons per square foot of bearing area.
Ordinary Clay—2 to 3 tons.
Dry Sand and Clay—3 to 4 tons.
Hard Firm Clay—4 to 6 tons.
Firm Coarse Sand—6 to 8 tons.
Firm Coarse Gravel—6 to 8 tons.
Bed Rock—15 tons.

The Floor. For convenience, the floor is often constructed immediately after completing the foundation walls to ground level; otherwise it is built after the walls have been finished and the structure practically enclosed. In any event, the floor must be constructed entirely separate from the walls and a joint must be provided between them, in order to permit unequal settlement without cracking.

In preparing the subbase for the floor all holes must be filled and compacted to avoid possibility of settlement.

Walls. Cement block or cement building tile, which are now easily available almost everywhere, constitute the very best wall materials for small and moderate sized

buildings on the farm and elsewhere. For all small buildings hollow block or tile 8 inches in width are preferable; for the lower walls of large barns blocks 12 inches in width are used in order to provide amply for the heavy loads carried. Methods of using these materials for the walls of small buildings are described on page 42.

Where cement block or tile cannot be had conveniently the walls may be built of monolithic or "solid" construction. Walls so built need not be over 6 inches thick for the average small building, and where limited to one story in height, a wall thickness of 5 inches is usually sufficient if the wall lengths are not over 30 feet. In such case pitched roofs must be provided with their own cross bracing, to make sure that no outward thrust is transmitted from the roof to the walls.

The foundation for a small building should start on a cement footing 12 inches wide and 8 inches deep, placed at the required depth. (See paragraph on Foundations page 66.) The 8-inch cement block may be laid on this and continued to the roof as illustrated on page 41. If the wall is to be built of concrete mixed on the job, forms may be set directly on the footings and the wall continued up of equal thickness from that level. In many cases, however, where a basement is not desired, the wall below grade is placed without forms in a trench dug as narrow as practicable, frequently about 10 inches. In such cases the saving in avoiding excavating and the use of forms justifies the use of more material in the wall below grade.

Forms in position for monolithic foundation wall

Proportions will be found in the Tables of Recommended Mixtures on page 12.

When laying foundations upon which wooden structures are to be erected, it is always advisable to embed anchor bolts in the concrete so that the wood sill may be firmly anchored to the concrete. This in turn serves to anchor the whole building against possible destruction from heavy winds if the timbers are well framed into or fastened to the sills by stud anchors. Where sills are not used, such stud anchors are themselves attached to the cement foundation by bolts previously embedded in the concrete at the time the last few inches of the foundation is constructed. See illustration on this page. These bolts are held in the position desired while doing final filling of forms, by suspending them from hangers resting across from inside to outside forms.

Roofs

Cement roofs, like other cement structures, reduce fire risk by eliminating the hazard of fire. Reinforced monolithic and a plastered cement roof formed on a base or ground of metal fabric are used both for pitched and flat roofs. Usually the cement roof is designed after the slab type with but little pitch.

Fig. 5, page 25, is an example of a typical slab roof.

Cement Roofing Materials. Where pitched roofs are desired and the unsupported spans are rather great, it is sometimes difficult to place cement slabs or plastered construction such as described in the preceding paragraph, and preference easily leads to the selection of cement roofing tile or cement-asbestos shingles where a permanent, fire-resistant and maintenance-free roof is desired. Either of these roofings will be found attractive, easy to lay and equally applicable to new or old roofs.

Rigid "asbestos" shingles, made by a process of pressing a rich mixture of asbestos fibre and Portland cement, are often preferred to slate for finest roofing purposes and should not be confused with flexible "prepared" roofing.

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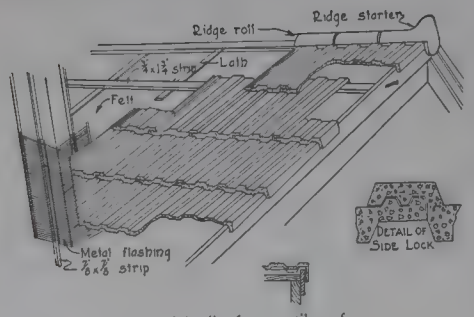


Typical details of cement tile roof

Cement roofing tile are constructed with double side locks, forming a perfect means for excluding wind and water. They are produced in heavy steel molds and cured on heavy steel pallets, making each tile smooth-laying and snug-fitting because absolutely true to shape; burnt clay products may be warped or twisted somewhat as a consequence of heat treatment. Both types of cement roofings are procurable in colors suitable for a wide range of uses.

"Concrete Masonry Construction" published by the Portland Cement Association, gives this information:

Cement Tile. "Cement roofing tile are generally produced in standard sizes of 9 3/16 inches by 14¾ inches (overall dimensions,) 150 tile being required per square of 100 square feet. Their weight is approximately 5½ pounds each. Typical construction details of cement tile roof are presented in accompanying illustrations. The supporting rafters should not be less than 2 by 6 inches in size, spaced 20 inches apart, center to center, connected with collar or tie beams to prevent spreading and covered with 1-inch seasoned sheathing, close laid and firmly nailed. With the aprons and counterflashing raised to admit the felt, the laying of the roof is done in this manner:

"Cover sheathing with approved 12-pound, or heavier, roofing felt laid parallel to the eaves and lapped at least half its width in every course. Lay an extra ply of felt next to the eaves; cap the hips and ridges with an extra longitudinal strip at least 12 inches wide and extend the felt up against vertical walls at least 6 inches under counter-flashing. In valleys lay one extra ply longitudinally.

"Lay continuous lath weeper strips on 18-inch centers from eave to ridge at right angles to ridge. Attach to the weeper strips and at the right angles to them, ¾ by 1¾-inch battens (accurately spaced to accord with the length of the tile). Lay tile carefully so that when finished the courses will present a straight and uniform appearance when viewed vertically, horizontally or diagonally. Cover hips and ridges with accurately laid ridge roll, bedded in 1:3 cement mortar colored to match roofing tile."

Cement Asbestos Shingles. Cement asbestos shingles are approximately 3/16-inch thick. They average in weight about 435 pounds per square (100 square feet) for the American (rectangular) type and about 275 pounds per square for the French, or diagonal, type. The method of laying is substantially the same as for common wood shingles except that conveniently shaped "specials" are provided for use at ridges, valleys and eaves.

Protection of Ceilings and Eaves. A protective covering of Portland cement plaster on metal lath may be expected to delay the passage of flames for an hour, and afford an effective protection against moisture and decay. Therefore, the underside of every wooden-framed roof should be protected by the application of cement plaster on metal lath to the ceiling and under-hang of the eaves.

Cement Roofing Tile

ALPHA CEMENT — HOW TO USE IT

Cement Poultry Houses

Hens can be made to produce large quantities of eggs and maintain such production if they are provided with suitable quarters and are otherwise well cared for. Sanitation is a large part of success in poultry raising. Good cement construction in a poultry house will improve sanitation by checking vermin and other poultry pests.

Foundation requirements are included in the chapter on "Small Cement Buildings." (Page 71)

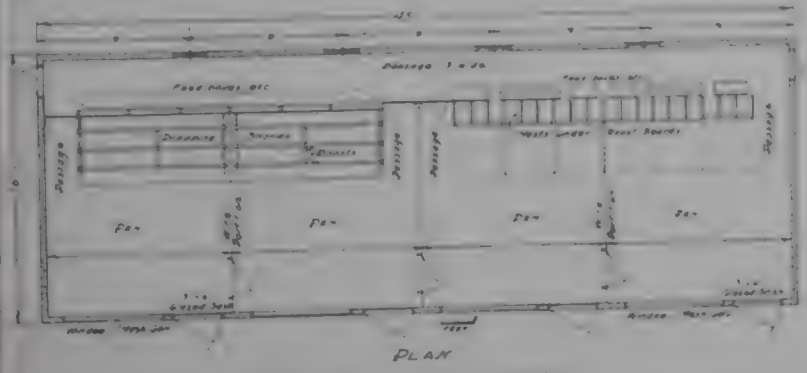
This design, which is for a cement poultry house 16 x 45 feet, may be halved if desired, without varying any of the construction requirements.

This poultry house plans ventilation from open windows covered with 1-inch poultry mesh and protected against extreme cold weather by muslin drop curtains. Dampness on walls of poultry houses can be avoided in the same way as in dairy barns and that is by proper ventilation.

Cement poultry houses are rat-and mouse-proof. Where the poultry house floor must necessarily be located on soil which is not favored with the best of drainage, then it is well to prepare a subbase on which to lay the floor. This should be preferably 8 inches of well-tamped, clean gravel, or cinders free from ashes, and this subbase should be connected at several points to tile drains that will prevent water from remaining beneath the floor. The floor should be of concrete construction, using a 1-2-4 mixture, and should be graded so that each dressing or soil drains off. Or, should be slight can be thrown any kind of clean litter for the animals to scratch in.

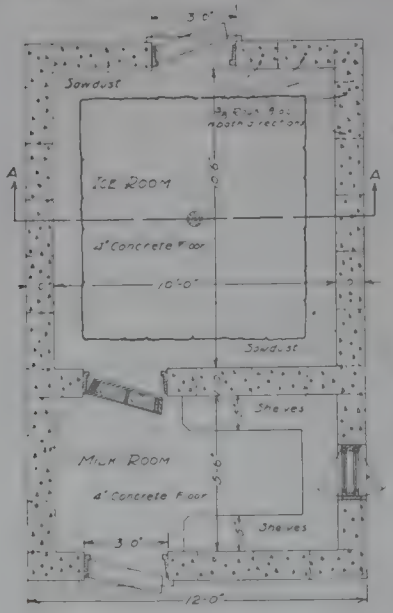
Poultry house walls should be of a 1-2½-4 mixture, in which the coarse aggregate consists of mixtures and gravel from ¼ up to 1 inch maximum size, or concrete of the thin wall section. See the chapter on "Forms and Reinforcement." The poultry house design here shown calls for only a 4-inch wall. Carefully constructed, this will sustain the weight well. Nevertheless, in general practice it would be better to provide for a 6-inch wall.

If the walls are of hollow cement block the thickness will be 8 inches, the narrowest practical width for hollow bearing walls.



Floor plan of well arranged cement poultry house

ALPHA CEMENT — HOW TO USE IT



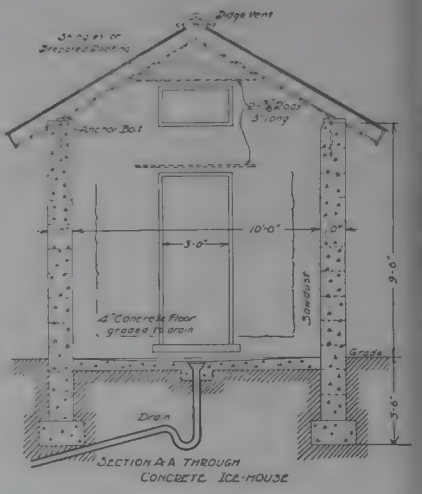
Plan for cement ice house with milk room

Cement Icehouses

To the average farmer, an icehouse is convenient and profitable. To the dairy farmer it is an absolute necessity. Idle days during the winter, put to harvesting and storing ice, bring the cost of ice very low.

Strange as it may seem, there is a fire-risk involved in the storage of ice. Sawdust or hay or straw is used for packing and probably the variable content of moisture in these materials causes decomposition and consequent heating in a way similar to the heating in the decomposition of manure, and this frequently results in fire.

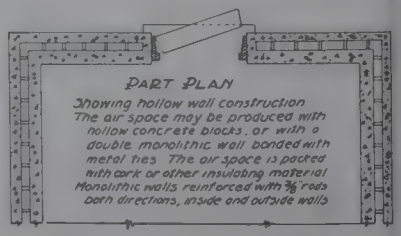
Wood is a poor material from the economic standpoint to use in icehouse construction. It is not fire-safe and soon rots out owing to the alternate wet and dry conditions to which exposed when the house is filled with ice, and from neglect when empty. No other material is so well adapted to icehouse construction as cement.



Sectional sketch of ice house

The accompanying drawings illustrate a convenient structure which may be built by either of two methods—first, with walls of hollow cement block and second, with double monolithic walls, either method providing an air space which will reduce to a minimum the melting of ice from outside temperature influences.

A number of modifications of the plan will suggest themselves to fit possible individual requirements. For instance, it is quite a simple matter to extend a cement constructed refrigerator compartment into the ice storage room so that this compartment will always be surrounded with ice and



Part plan showing hollow-wall construction

hence serve as an actual cold room for eggs, dressed poultry, milk and cream.

The floor of cement construction slopes in all directions toward a central drain. This floor is made independent of the side walls and should be so laid that there will be a ½-inch joint all around which can be sealed against leakage and entrance of air, by pouring into it hot tar or asphalt. The drain is "trapped" so that the water from ice melting will seal it against the possible entrance of air, thus preventing rapid melting of ice.

The smallest practical dimensions for the farm icehouse should be considered as 10 x 10 x 10 feet, giving contents of 1000 cubic feet. Since a cubic foot of ice weighs about 57 pounds, such a house would hold about 20 tons allowing for the usual waste of space in packing ice.

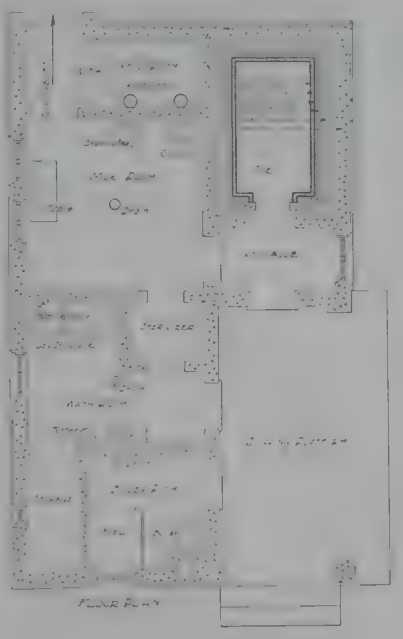
An icehouse should be located in a place convenient to the dairy barn, and on dry, well-drained ground. Building below the ground makes drainage difficult and removal of ice to the ground level equally difficult. It is generally more costly too, for an underground ice house requires the same material and expense in building as one above ground in addition to the cost of greater excavation. The soil is a good conductor of heat. During a large part of the year, ice will melt less in a surface storage room exposed to actual contact with air than in underground storage.

Although the accompanying plans show a wood frame and shingle roof, a cement roof is by all means preferable. This also must be built so as to provide insulation which is accomplished by constructing, independent of each other, two sets of slabs suitably reinforced and separated from each other by a layer of clean, coarse cinders. There is true economy in the cement roof since it is permanent, and in connection with the remainder of the construction, accomplishes complete fireproofness.

Send for "Permanent Farm Construction"—72 pages, illustrated—free. Address, Portland Cement Association, 33 West Grand Avenue, Chicago.

Cement Milkhouses

Many city health authorities having the power to regulate the conditions under which the city milk supply is produced, require that cement construction be used throughout dairy buildings on the farms furnishing milk, so as to make certain that sanitation can be maintained. Such regulations are enforced by State authorities as well.



Cement milkhouse

Accompanying designs show a very convenient layout for the dairy-farm milkhouse. Even the shipping platform is of cement construction, so that everything about the structure is permanent. Fireproofness also is secured, which is quite necessary since the boiler room is a part of the building. The method of securing insulation for the ice compartment is shown in detail. Otherwise its construction is not unlike that described elsewhere for a small icehouse.

ALPHA CEMENT — HOW TO USE IT

Cement milkhouse

In this design the shipping platform is specified as 4-inch reinforced concrete. It would perhaps be better if this were made 6 inches thick as it would then be easier to place reinforcing and make certain that it was everywhere surrounded by and perfectly bonded with the concrete.

Although a good interior wall finish can be obtained by mixing the concrete to correct consistency and carefully spading when placing in the forms, it is always desirable to have an exceptionally smooth wall in a milk room so that the surface can be kept thoroughly clean, and it would be well after removing forms to rub down the concrete to the desired smoothness by using a carborundum stone or some similar abrasive, and when the concrete has become thoroughly dry to give the wall several coats of white enamel paint of a kind prepared especially for use on cement surfaces. This will seal any pores on the surface and will be an incentive to greater cleanliness, since any dirt that may lodge on the white surface can readily be seen.

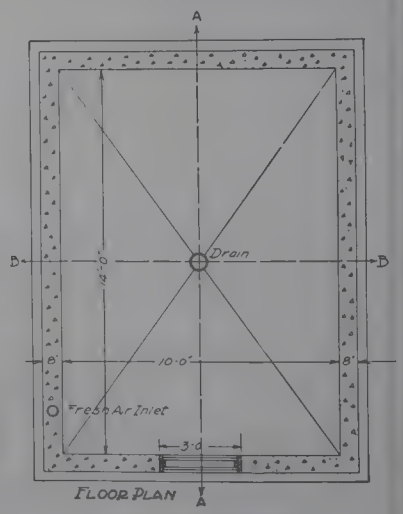
A cool and maintenance-proof building of cement block construction

Fruit or Vegetable Storage Cellars

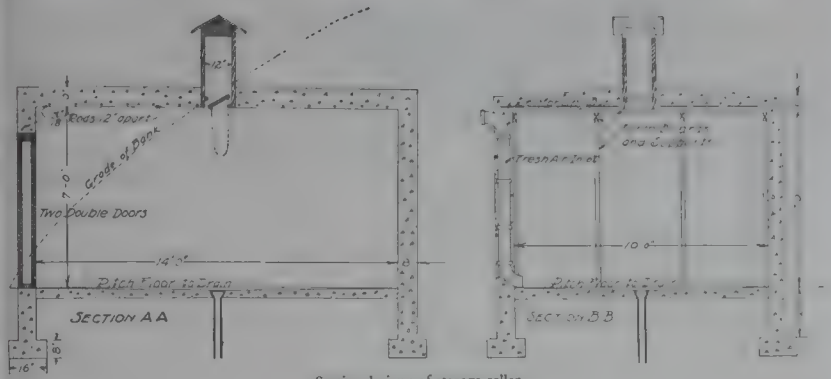
Accompanying sketches show in plan and longitudinal and cross-section a cement fruit or vegetable cement storage cellar 10 by 14 feet. A structure of this kind should preferably be located in a hillside or at one side of a knoll, and if so located the necessary excavating will provide sufficient earth to bank the structure and cover the roof, which although not essential, is desirable to assist in maintaining an even temperature inside the cellar.

Although not shown on the plans, a structure of this kind should have reinforcing in walls, especially when set into the side of a hill or a knoll, to prevent earth pressure from cracking the walls. For a structure of this size ⅜-inch rods, spaced 18 inches center to center, will probably be sufficient. The sketches illustrate a system of ventilation, which is quite essential in such storage cellars to prevent dampness which would not be best for stored fruits and vegetables.

Ventilator pipes are of 6-inch cement tile. The vents should be covered with galvanized wire mesh to exclude rats and mice. It is a good idea to lay a raised plank



Plan of cement storage cellar

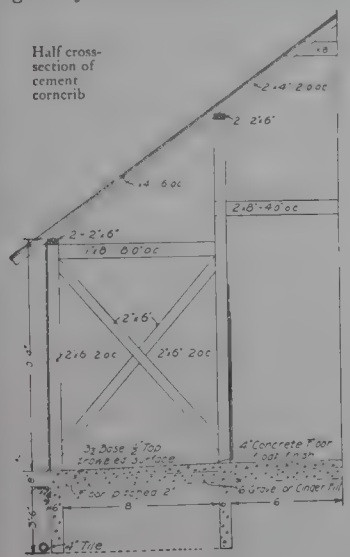


Sectional views of storage cellar

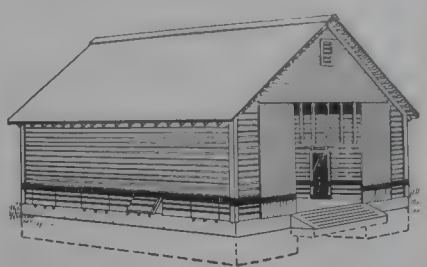
floor over the cement one and to divide the cellar into bins with 2-inch plank partitions, nailing planks ¼ inch apart on 2 by 4 studs so that there will be ventilation all around the stored contents.

Ratproof Corncribs

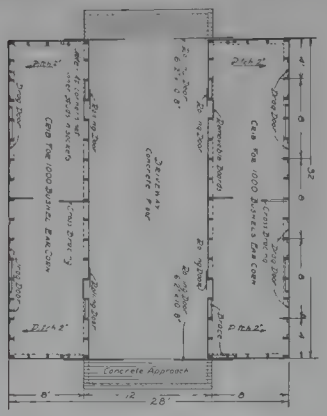
Accompanying designs show a corncrib designed by the United States Department of Agriculture, in which ratproofness is secured by cement foundation walls and floor and a fender strip that prevents the rats from climbing up side walls. The crib is a double one, each compartment having an estimated capacity of 1,000 bushels of ear corn. The driveway as well as the floors in the cribs proper are paved or floored with cement. Construction of such floors has already been described under the heading "Walks and Floors." In setting up forms for the cement floor in the cribs the form boards should be set so that the floor will have a slope of at least ¼ inch to the foot. This slope should, of course be toward the outside.



It is also possible to build corncribs of cement throughout, using cement corncrib blocks having openings extending through them and slanting downward to prevent the entrance of rain.



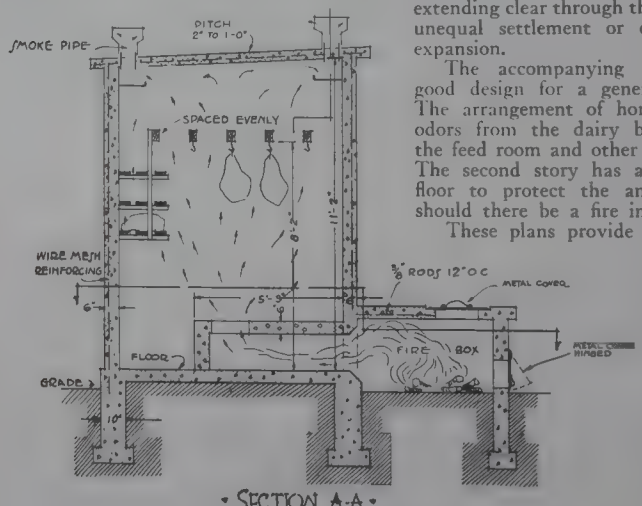
Good type of corncrib



Plan of cement corncrib

Cement Smoke House

Suggested plan for a reinforced cement smoke house with fire-box placed outside of the building is shown in the accompanying sketch. The fire-box is so designed that in joining the smoke room there is a down draught, thus preventing the fire from burning too freely, and causing it to smoulder and smoke instead. Such a structure should be at least thirty days old before put to use.



SECTION A-A

Barns, Stables, Silos, etc.

The advantages of a barn of cement construction are made apparent by what has already been said elsewhere about first cost, maintenance cost, proof against fire, vermin, weather and other deteriorating influences.

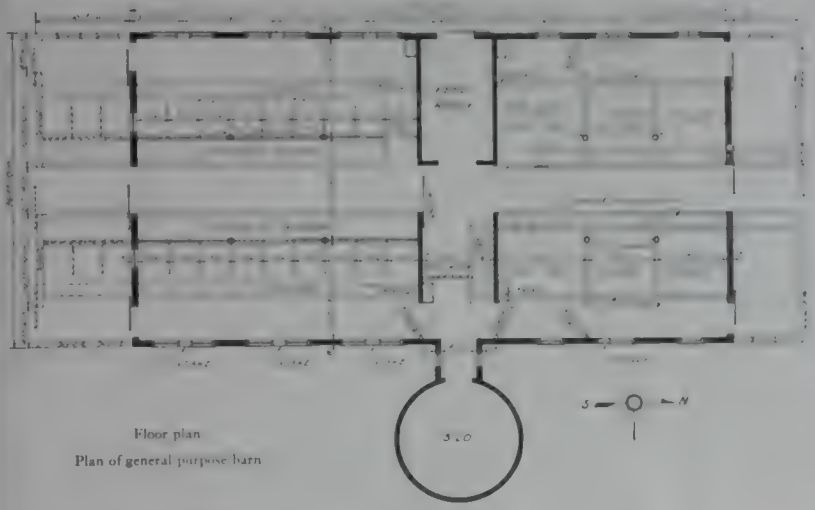
Barns may be built of block or monolithic cement construction. The foundation walls should be 12 inches thick, following in construction the suggestions made in the data on Foundations, on pages 42 and 64. Walls above ground for two-story barns should be not less than 10 inches thick.

Floors should be built with care, as suggested elsewhere in this book. They should be 5 or 6 inches thick for one-course construction. Where animals walk or stand, the surface should be finished with a wood float to give an even but non-slipping surface. Over-troweling often causes checking. Barn floors should be laid in slabs not larger than 10 feet in any one dimension with joints extending clear through the floor, to prevent unequal settlement or cracks caused by expansion.

The accompanying sketches show a good design for a general purpose barn. The arrangement of horse stalls excludes odors from the dairy barn proper, from the feed room and other dairy apartments. The second story has a fireproof cement floor to protect the animals underneath should there be a fire in the hay storage.

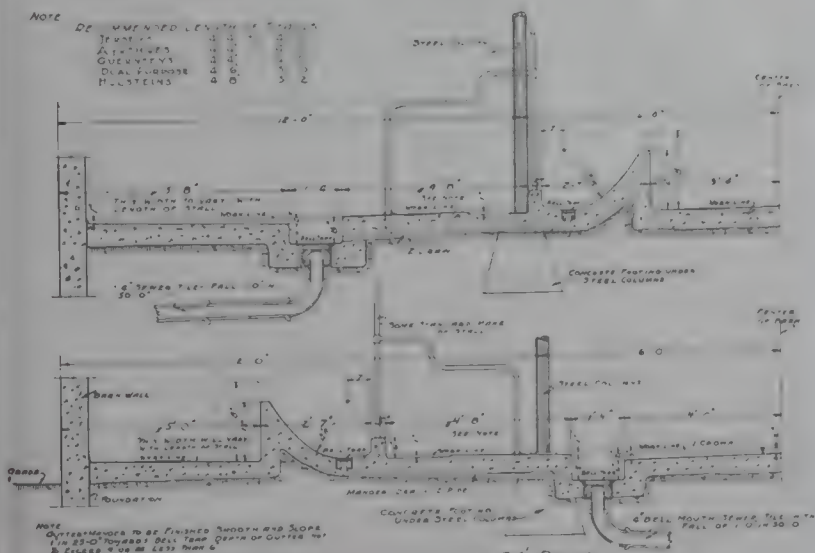
These plans provide good facilities for indoor lighting. The United States Department of Agriculture recommends 6 square feet of opening for each animal and gives 4 square feet as an absolute minimum. Figure on ample room for the animals.

ALPHA CEMENT — HOW TO USE IT



Floor plan

Plan of general purpose barn



HALF SECTIONS THRU COW STALLS OF 36' BARN

• COWS FACING IN •

• COWS FACING OUT •

Dairy Barn floor construction

ALPHA CEMENT — HOW TO USE IT

Perspective View of General Purpose Barn

Cement Stable or Barn Floors

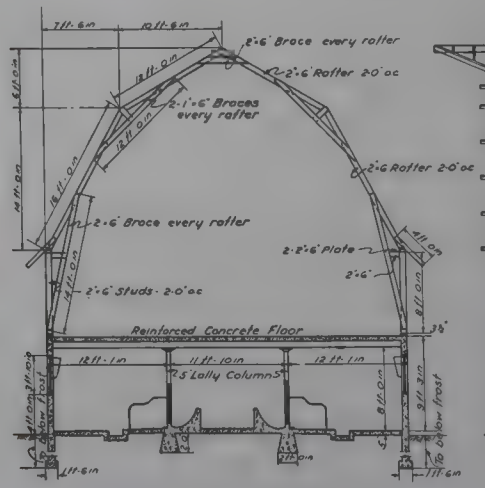
All refuse and soft earth is removed from within the barn and the floor laid out, excavating or filling in as necessary to bring the subgrade to the required level. All portions of the subgrade must be thoroughly tamped to insure a sound base for the concrete.

Recommended dimensions are secured by reference to the cross-sectional illustration shown on the preceding page, approved by the American Society of Agricultural Engineers.

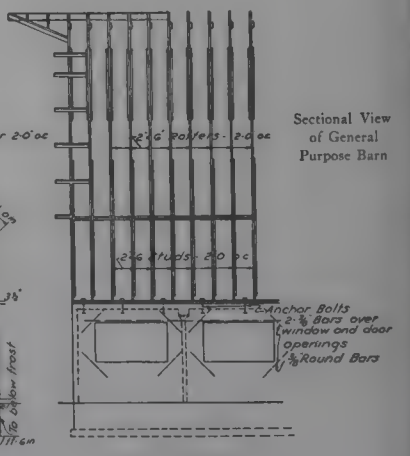
It is usually considered easier to proceed by placing the manger curb first. Stanchion supports are carefully placed to secure perfect alignment and anchorage. The greatest care must be exercised in getting the proper level for this curb, then carefully taking levels from it for other parts of the work. Steel stall partitions are next erected, after which stall floor, gutter, manger and alleys are completed, usually in order mentioned. Most manufacturers of stall equipment furnish patterns or templates with directions for use in with their particular appliances.

All portions of the work except the curbs, mangers and gutters must be finished with a wooden trowel, securing the desired grade and a surface smooth enough to be sanitary and easily cleaned, yet sufficiently rough to prevent the animals from slipping. Round interior and exterior corners to make cleaning easy and to afford more comfortable surfaces for the animals.

The entire thickness of the floor, manger, gutter, etc., are conveniently placed in one operation or as "one course work" for a 1:2:3 mixture is recommended, having a jelly-like consistency. In finishing the surface, a small amount of 1:2 mortar may be added if necessary to secure sufficient smoothness. Gutters and mangers should be sloped at the rate of ¼ inch to the foot toward drain outlets.



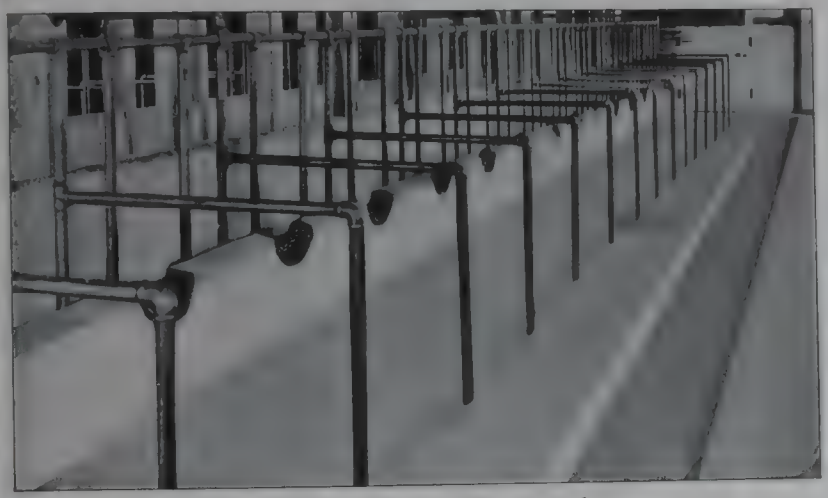
CROSS-SECTION THRU COW STALLS



Sectional View of General Purpose Barn

SIDE FRAMING

ALPHA CEMENT — HOW TO USE IT



View in a model dairy where cement replaced wooden floors

Model dairy barn, showing cement feeding alley between rows of stanchions

Caring for Cattle and Floor. Regardless of the kind of floor, bedding of straw or litter is an absolute necessity; it keeps the cow clean and absorbs the valuable liquid manure. If the help cannot be depended on to bed the cows properly, it is advisable to use a removable wooden grating or platform. Cork bricks, set two inches in the cement, are often used.

Feeding Floors

When feed was thrown out on the old-fashioned feeding lot, part of it was eaten and part trampled into the mud and wasted. Wood feeding floors were no improvement. They harbored rats and often became so unsanitary as to menace the health of the herd.

Cement feeding floors which overcame all of these things, have been said by conservative men to be able to pay for themselves in a year.

Details of construction are similar to those described elsewhere under "Walks and Floors." The location should be one where drainage is good and if possible where the animals to be fed will be afforded protection from wind. The site should be cleaned of all vegetation, and any soft spots dug out and refilled with gravel containing only a small amount of sand or with clean cinders free from ashes, and well compacted. The floor should be sloped toward one side where there should be a gutter that is connected to a tile line leading to a manure pit so that all of the animal droppings on the floor can be preserved.

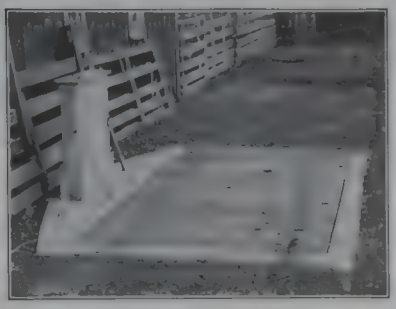
Feeding floors should be made preferably not less than 5 inches thick and of one-course construction, being laid in slabs no greater than 6 feet in one dimension (36 square feet in area). In finishing, one should use a wooden float instead of a steel trowel. The wood float finish largely does away with the possibility of hair cracking and leaves a gritty texture to the pavement surface that provides a good foothold. A cement feeding floor should be washed off occasionally with broom and water, and in case of stock disease, and the necessity for thorough disinfection the surface may be sprayed with gasoline and the gasoline set afire, thus destroying all disease germs.

A feeding floor should always be built with a curb around it extending two or three inches above the floor level to prevent the animals from shoving feed off the floor when eating. This curb should also extend a foot or eighteen inches below the bottom of the floor to prevent rooting under it.

Cement feeding floors save grain, labor and fertility. They quickly pay for themselves

ALPHA CEMENT — HOW TO USE IT

Cement increases hog comfort; prevents disease



A frame that will stand hard use

Cement Hog Wallows are Profitable

Hogs will keep clean if given a chance and it is certainly to the interest of every hog raiser to protect the health of his animals by putting in a cement wallow. In this way disease is avoided and the hogs gain faster because they are more comfortable. Hogs have a strong instinct to cool themselves by bathing, and unless a clean place is provided they are sure to pick out a damp or wet spot in the mud, fashioning it into a wallow which soon develops into a breeding place for disease.

Most cement wallows are made by scooping out the earth into the shape of a shallow bowl, using a board template swinging around a vertical rod set up as a center. When properly excavated and compacted, the concrete is placed exactly as for a floor except for the curvature. The slab should be made 5 inches thick of 1:2:3 concrete, the top being brought to shape by means of the template device, a wooden straightedge and a small wooden trowel. The concrete is reinforced with a thickness of bull fencing or other heavy woven wire material laid midway between bottom and top of the slab.

The maximum depth should be about 18 inches, so that the greatest water depth will be about 15 inches. A circular opening, connected to a tile drainage outlet should be provided for use in draining the tank. This opening should be fitted with a wooden plug. An apron or curb is often placed around the wallow to prevent rooting under it. Similar construction is used for rectangular wallows which are somewhat more difficult for the amateur, for which reason circular wallows are often preferred.

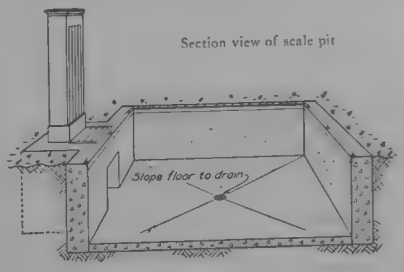
Scale Saves Many Times Its Cost

A platform scale securely and permanently installed in a cement pit will weigh accurately and require no attention or outlay for repairs. Used to weigh supplies purchased as well as produce and animals shipped, it prevents losses and arguments. Without a good scale the farmer must depend upon the other fellow's honesty and accuracy.

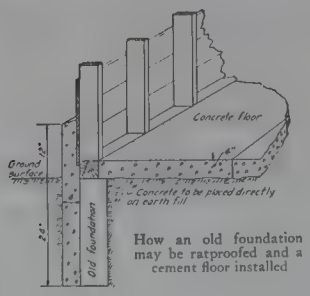
Construction of the pit is very simple. A high, well drained site is selected if possible and a foundation wall of monolithic concrete is placed as shown in the sketch, according to dimensions furnished by the scale manufacturer. To protect the inner edge of the surface, 1½-inch angle iron strips are set in, being anchored to the concrete by means of bolts embedded at intervals of three feet.

A tile drain is placed with drain trap in the center of the floor, sloping the floor to it. The tile must be carried to a suitable outlet. The floor is laid according to general directions contained on page 66.

Section view of scale pit



ALPHA CEMENT — HOW TO USE IT

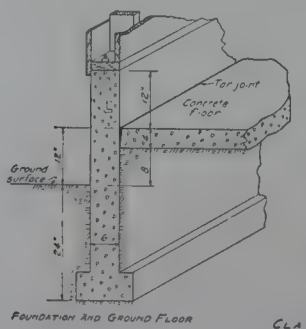


How an old foundation may be ratproofed and a cement floor installed

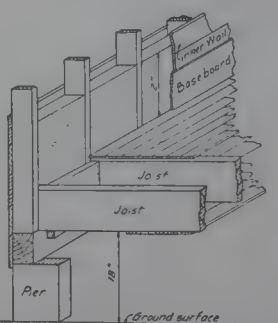
Ratproofing Frame Structures

If farm buildings are built of cement construction rat problems quickly disappear; if the structures are of frame, concrete will effectually ratproof them. The upper illustration shows the method by which wooden foundations are ratproofed by the use of a "false" wall of concrete 4 inches thick, extending 24 inches below grade and 12 inches above grade. If more convenient, the false wall may be placed inside the foundation.

The lower illustration shows an effective method of building out rats and mice in the case of buildings supported on posts or piers. Where this construction has been used, the building should be raised if necessary, until the distance from ground to floor joist line is at least 18 inches. The mixture should be just wet enough to flow into place. If there is room the concrete may be tamped to make sure that the space is completely filled.



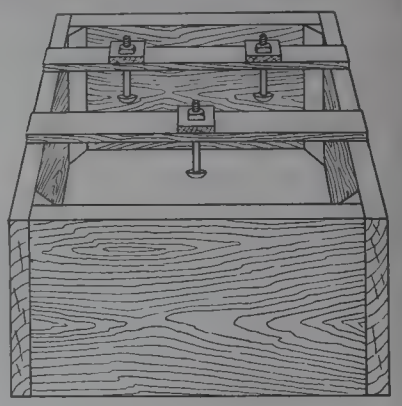
Showing a good method of making foundation and floor of a new building ratproof



Buildings supported on piers are ratproofed by raising above ground level and placing concrete between walls above sills

Cement Engine Bases

Cement is the only really acceptable material for stationary engine bases. Vibration is absorbed and the engine kept plumb and in perfect alignment, factors which lengthen its life and reduce noise to the minimum. Engine bases are usually simply



Form for cement engine base

rectangular blocks of concrete in which are embedded the necessary bolts for attaching the engine frame. Simple box forms, like that shown, are all that is required for the making of small bases, the template boards across the top being used to assure proper location of the engine bolts. The forms are carefully removed as soon as the block is strong enough to permit, and the surface troweled after which it may be coated with a creamy mixture of cement and water.

For engine and pump bases 1:2½:5 concrete is ordinarily employed, using particles as large as 2 inches in diameter and mixing with just enough water to give the mass a "quaky" or "jelly-like" consistency. Surfaces are carefully spaced, the top lightly tamped.

Thousands of cement stave silos are profitably employed by dairymen

Cement Silos

Even for the smaller dairyman or stock-raiser, a good silo will provide both profits and feed insurance. The silo not only produces more and better feed from a given acreage at less labor and expense, but it removes much of the risk by safely storing succulent fodder from one fresh-feed season to the next. Silos very often pay back their entire first cost in one filling and may be depended on to do so in two or three fillings. The permanent, maintenance-free cement silo then remains a constant source of profit without any outlay whatever.

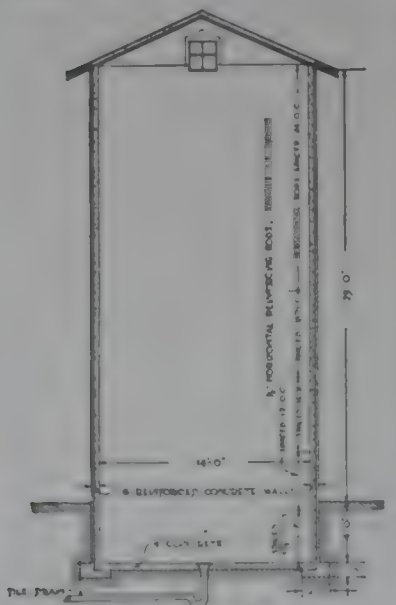
Cement silos are fireproof and therefore not at the mercy of barn or stack fires; when properly packed they are air-tight, keeping silage with minimum spoilage. Losses from rats are unknown. Cement silos are not attacked by rot and they stand secure whether full or empty. Three types of cement silos are all giving excellent satisfaction—whether built monolithic, of cement blocks or of cement staves.

Where convenient it is desirable to have a competent contractor build the silo. The cement stave silo has become immensely popular during recent years and contractors in nearly all parts of the country specialize in manufacturing and erecting them. This type is an assembly of small cement slabs, usually 30 inches long, 10 or 12 inches wide and 2½ inches thick, so formed that they interlock or fit together tongue-and-groove fashion. The silo rests on a heavy cement footing, similar to those prescribed for monolithic silos. The staves have opposite sides exactly parallel, so that when tightly held in position by steel hoops they fit so closely as to produce an air-tight and water-tight tank. They are coated on the inside with a flint-like cement paint or enamel which acts as a further seal and produces a smooth surface to which silage will not cling.

Cement block and monolithic silos are built largely by contractors, although a

These handsome monolithic cement silos adorn as well as serve a prosperous mid-western dairy farm

ALPHA CEMENT — HOW TO USE IT



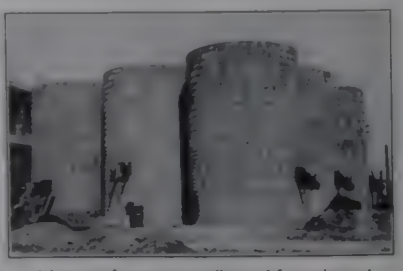
great many farmers have built their own silos of Alpha cement. Regular silo contractors are prepared to do much better work, however, and experience has shown that their prices average very little more than for home made silos, figuring owner's time at a fair rate. Farmers who select the monolithic type of silo may do so with the assurance that although slower to build and requiring more material, it is without question the most substantial structure obtainable, and is especially recommended as a pedestal for water supply tanks, the great weight of which makes it inadvisable to place them on silos of other types.

The Alpha service department will gladly supply service sheets containing complete information for the farmer who desires a monolithic silo. These show how to build substantial forms, handle the reinforcing, construct the roof and care for other details of the work in proper manner. "Concrete Silos—Monolithic and Block" by the Portland Cement Association contains much valuable detail information which may also be had free on request.

Monolithic Silo Pointers. In order to be air-tight and water-tight, the concrete for the walls must be of jelly-like consistency carefully spaded next to the forms; provision must be made so that doors will fit perfectly and a tight roof and chute should be provided, without ventilators. Medium wet concrete will insure dense smooth wall surfaces which not only keep out air and water, but they allow silage to slip down easily, thus avoiding air pockets. The weight of a cement silo requires that the footings be made a full 2 feet in width, resting on firm soil, below frost penetration. Four feet is a good depth for the silo tank. The reinforcing must be as specified in Alpha service sheets, and accurately spaced in the center of the wall. In leaving off and resuming work the practice suggested in the chapter on "Making Concrete Watertight" should be adhered to.

About Cement Block Silos. The block used for cement block silos are usually of the hollow variety, made on the circumference to correspond with silo diameters of 12, 14, 16 and 18 feet. The footing is made as for a monolithic silo, starting the first course of block directly upon it. In order to obtain a neat and efficient job the block should be laid by a first class mason. The interior surface is given a light plaster coat with 1:2 cement and sand mortar.

Cement Staves. Cement staves are used extensively not only for the walls of silos, but for stock watering and grain tanks, coal pockets and many other circular



A battery of cement stave silos used for storing and handling coal

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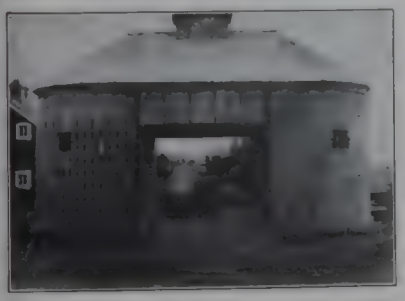
farm structures as well. There are also many rectangular structures such as barns, poultry and hog houses and corn cribs built of these units. Such work is always done by experienced cement stave contractors and invariably proves very economical when compared with the cost of less enduring types.

Capacity of Silos. The size to build depends upon the number of animals to be fed daily and the quantity of silage in pounds required for each animal, as well as the number of days it may be necessary to feed them. Dimensions of a silo should be fixed in accordance with the size of the herd so that a day's feeding will represent the use of not less than 2 inches of silage. This will prevent the molding of a thin top layer. The ordinary dairy cow requires about 40 pounds of silage per day, and the table below gives suggestions as to the dimensions of silo to build for herds of various sizes and to provide for different terms of feeding based on the 40-pound daily ration.

The "cow" [illegible] silos, [illegible] are [illegible]

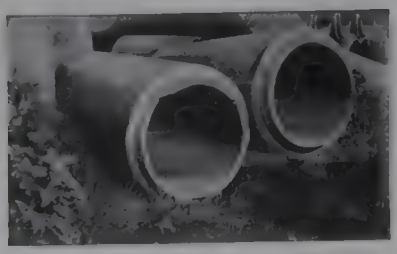


A cement stave granary, one side accommodating ear corn, the other small grain.

Free [illegible] on [illegible] and repair [illegible] permanence in cement construction.

DIMENSIONS OF SILO ACCORDING TO SIZE OF HERD

Number of Cows in Herd	Feed for 180 Days				Feed for 240 Days			
	Estimated Tonnage of Silage Consumed	Diameter of Silo	Height of Silo	Cows Average Required Daily Ration Each	Estimated Tonnage of Silage Consumed	Diameter of Silo	Height of Silo	Cows Average Daily Ration Each
	Tons	Feet	Feet	Ounces	Tons	Feet	Feet	Ounces
	30	10	25	2½	48	10	31	3½
10	48	10	38	4	57	10	45	4
12	43	10	29	4	72	11	36	5
15	54	11	32	5	96	12	39	6½
20	72	12	42	5	120	13	40	8
25	90	13	33	6	144	15	37	10
30	108	14	34	7½	168	16	38	11
35	126	15	33	8½	192	17	39	13
40	144	16	35	10	216	18	39	14½
45	162	16	37	11	240	19	39	16
50	180	17	37	12	288	20	40	19
60	216	18	39	14½	336			
70	252	19	40	17				



Cement pipe in fine condition after a generation of use

Cement Well Platform

There are several methods of building a cement well platform. The choice is dependent on the manner in which the pump barrel and stock are joined together. In the illustration is shown a platform 5 inches thick and 5 feet square, which contains a manhole fitted with a cement lid. The pump stock passes through the platform by means of a circular hole at the side and a part of the manhole opening. By this means the pump stock and barrel can be joined together and slipped into position by a person working through the manhole. Afterwards the cement manhole lid is set in place. Moreover, this lid is heavy enough that it cannot be removed by a child.

In preparing the well for a cement platform, see that 4 or 5 feet of the curbing near the top of the well is of solid concrete, or of blocks or bricks laid up with cement mortar mixed in the proportion of 1 part cement to 1½ parts sand. Carry the curbing 6 or 8 inches above natural ground level and grade the turf to this height so that surface water will flow away from the well. Prepare to mold the cover on a wooden platform of 2-inch boards laid over the well or placed on a level spot of ground. For most wells, a platform 5 feet square by 4 inches thick is sufficiently strong. To provide for a manhole opening, build a bottomless box, of 1 by 6-inch boards, 5 inches deep, 2 feet square at the top and 18 inches square at the bottom—outside measurements. Another plan is to have a tinsmith make a round bottomless tin form 5 inches deep, 2 feet in diameter at the top and 18 inches at the bottom, after the pattern of a large bottomless dish-pan. To either manhole form attach a wooden block of the size and shape of the pump barrel or stock. Grease the manhole frame and set it on the wooden platform where the opening in the well cover is desired.

Have the concrete just wet enough to flush a little cement mortar when tamped into place. Over the entire wooden platform, except within the manhole frame, spread 1 inch of concrete. For reinforcing, immediately place on this concrete 5-foot lengths of ⅜-inch iron rods running in both directions (criss-cross) and spaced 6 inches apart. Bend the ends to a hook-shape. Strengthen the platform around the manhole opening by placing an additional rod on each side. Bring the cover to its full thickness at once by tamping in the remaining 4 inches of concrete.

For fixing the base of an iron pump securely to the finished well platform, place in the soft concrete around the pump opening ordinary bolts (washered and heads down) to the depth of 4 inches. To locate these bolts correctly, set them by means of a wooden block or template in which holes have been bored and spaced exactly like those in the pump base. Lag bolts or similar devices may also be used for this purpose. Finish the surface of the platform with a wooden float, just as would be done in the case of sidewalks. If the greased tin form is used, the manhole cover may be cast at the same time as the rest of the floor. Reinforce the lid with short lengths of iron rods laid criss-cross. As a lifting ring use half of an old bridle bit, or a hitching-post

Sanitary well platform of cement

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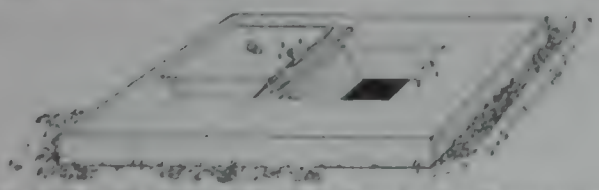


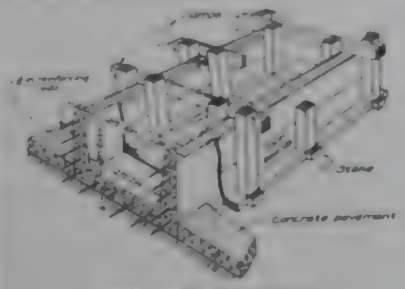
ring, the end of which is provided with a knob of twisted wire or with a nut and large washer. If the wooden manhole form is used, carefully remove it after four hours. One day later build the manhole lid the same as for the tin form with this exception—place greased paper or cardboard around the edges of the opening to prevent the new concrete from sticking to that of the platform. To make the manhole lid lighter in weight, before placing the concrete, spread 1½ inches of wet sand over the wooden platform inside the manhole opening and then tamp in the concrete. Take care to place the reinforcing within 1 inch of the bottom of the manhole lid.

After the well platform is two weeks old, carefully remove the wooden boards on which it was built and set or lower it into place.

Feeding and Watering Troughs or Tanks

Cement tanks or troughs are more easily kept in sanitary condition than those of any other material and they have a very decided advantage from the standpoint of permanence.

Good type of cement watering trough



fresh concrete, and after ten days or two weeks may be carefully moved to the place where they are intended to be put to use.

As in many other classes of cement work, the best materials and workmanship will count for little or nothing unless the concrete is properly protected after being placed to prevent too rapid drying out and this is very important in connection with troughs or tanks, which if allowed to dry out rapidly would be porous.

Hotbeds

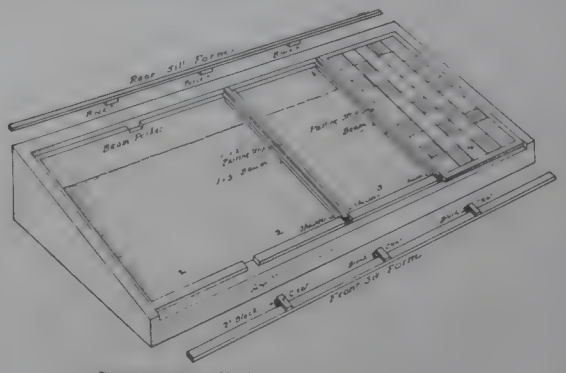
Most of the wood used in hotbed construction is in contact with the soil and rarely lasts more than two seasons, while if concrete were used such construction would be permanent and the slightly increased first cost would soon be compensated for by doing away with repairs and rebuilding.

Usually cement hotbeds require only the simplest of form construction, and where the ground is self-sustaining only an inside form will be required for the cement work below ground level. At ground level, both inside and outside forms must be provided for the walls above ground.

The dimensions of the bed should be such that standard storm window sash, six feet long by three feet wide, will exactly fit. Such sash are available almost everywhere at low cost. The sash should be primed and painted in order to preserve them against rapid deterioration from exposure to the weather.

Well located cement hotbed

For hotbed construction a 1:2½:4 concrete will be suitable. Walls should be from 6 to 8 inches thick with two ⅜-inch round rods bent to a right angle at each corner, these rods being 4 feet long and extending 2 feet into end and side walls. When finishing the back wall (which is the higher one) to provide for slope of sash, it is very easy to embed fastenings in the concrete for attaching sash hinges. A very convenient adjunct of the cement hotbed is a 2- or 3-foot cement walk on the low side, so as to make it easy to get around the bed during periods when the ground is wet. This feature considerably increases the ease and comfort of working in and around the bed. No stretch of cement hotbed wall should be longer than 25 feet unless the next section is completely divided from it by a contraction joint, as the expansion and contraction due to temperature changes in a stretch of hotbed wall longer than 25 feet is quite likely to result ultimately in cracks in the wall.



Perspective view of hotbed showing the last sash in place

Greenhouse with Cement Walls, Floors and Benches

In the hot, moist air necessary for cultivating or forcing plants under glass, wood construction soon goes to pieces from rot. This suggests cement for all portions of a greenhouse which need not be of steel frame and glass.

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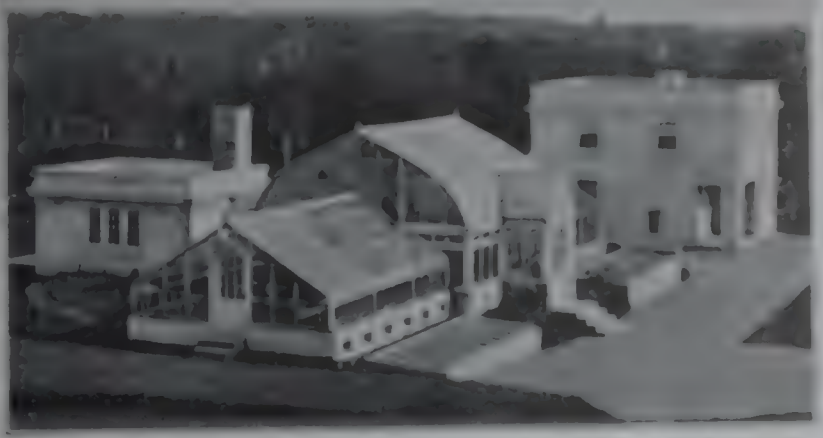


a roof, and with a sump or cistern into which the liquid contents will drain and from which they can be pumped for sprinkling on the land when convenient. It is quite desirable to roof the pit and screen it with fly screen fabric, to prevent the manure pile from becoming headquarters for fly breeding. This is especially true on the dairy farm, where milk must be cared for in a sanitary manner, which means keeping flies down to a minimum.

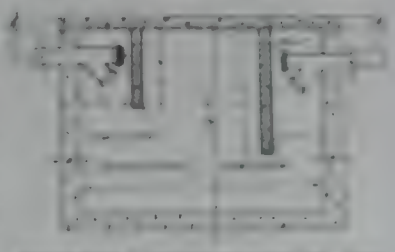
Manure pits should be conveniently located with reference to the barn so that if desired litter can be carried directly from the stable to the pit by a litter carrier, as shown in two of the accompanying views. The inside wall face of the pit should be sloped and all corners slightly rounded so that the manure can be properly packed in the pit to thus control decomposition. Some pits are built without a wall at one end and the floor sloped upward to ground level so that a wagon can be backed in for loading. In most cases a relatively shallow pit is best, that is one where the manure cannot be piled to a greater depth than 3 feet.

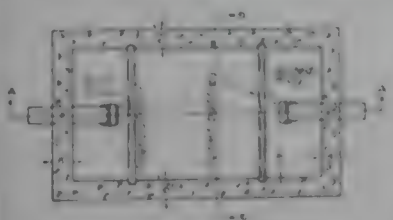
Manure Pits

Home Sewage Disposal Systems

Wherever a residence can be connected with a city or town sewer system this is, of course, the ideal way to dispose of house wastes. But where the advantages of a sewer are not available, as in the case of homes in sparsely populated communities or farming districts, a home sewage disposal system employing a septic tank and filter bed, will be found entirely satisfactory. In fact it provides the only really safe method of disposal in such cases, and without it modern plumbing is an impossibility in the farm home.

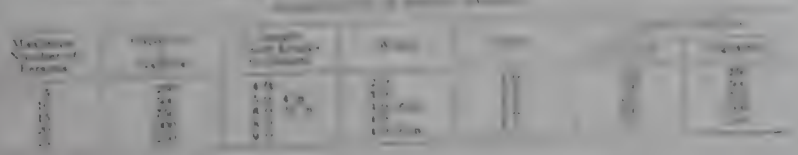
ALPHA CEMENT — HOW TO USE IT





Dimensions for Septic Tank and Length of Irrigation Tile

The Irrigation System



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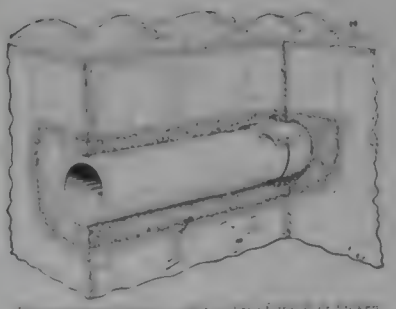
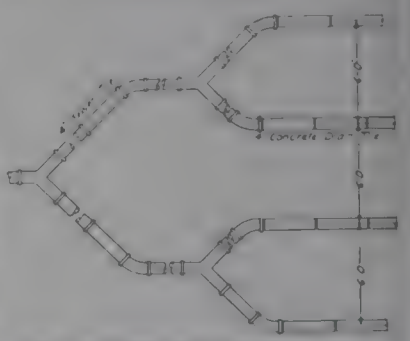


[illegible] of broken

it may seep through a bed of gravel into the earth. The length of the tile line required to properly take care of the effluent is indicated in the foregoing table presupposing that [illegible] for every 12 feet of tile thereafter. The tile are laid [illegible] open joint, like drain tile, on a bed of gravel or [illegible] stone, the slope of the line being carefully checked to make sure that it is uniform.

If the tile are installed as indicated abundant aerobic bacteria will live in the tile and the surrounding stone and soil. They require only sewage and oxygen to thrive and thoroughly decompose and purify the liquid effluent of the tank.

The septic tank is often placed near the house and a tight sewer line laid to connect it with the sub-irrigation system. In flat locations the tank is placed as high as possible in order to afford maximum pitch for the tile lines; where it is impossible to get about four feet drop from tank to end of lines, an automatic syphon or flush tank chamber is installed which retains the tank effluent and intermittently flushes it.



This method of tiling gives a large irrigation area for relative short length of tile

Construction view of two-chamber septic tank

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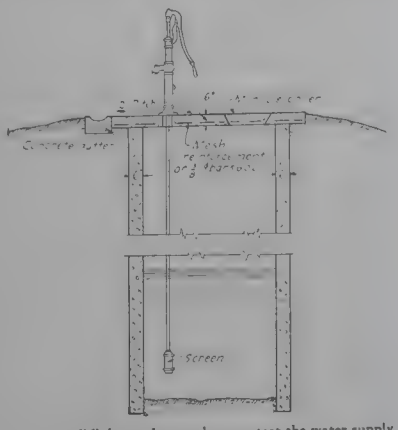
Durable cement tables at auto campgrounds

Cement Work for Tourist Camps

Good roads have made possible cross country touring by automobile, and improved tourist camps will add much to the pleasure of such trips. Camp ground equipment should be as nearly as possible weather resistant, fireproof and sturdy enough to withstand hard usage. Permanent tables and benches, provision for water, toilet facilities, stoves, refuse burners and washing platforms, are some of the facilities that every camp should have. Most of these improvements are applicable to private camps, fishing and hunting lodges as well as to public camps for auto tourists.

Cement tables and benches are simple to make, the tops and pedestals being cast separately in wooden molds. The molds for the pedestals are made so that the latter are cast with outer side or face down. The mold may be made of even simpler design than shown here, the various parts being held together with screws so that they may be loosened to permit easy removal of the piece. The tops are merely flat slabs reinforced with rods as shown in the sketch.



Cement well lining and pump base protect the water supply

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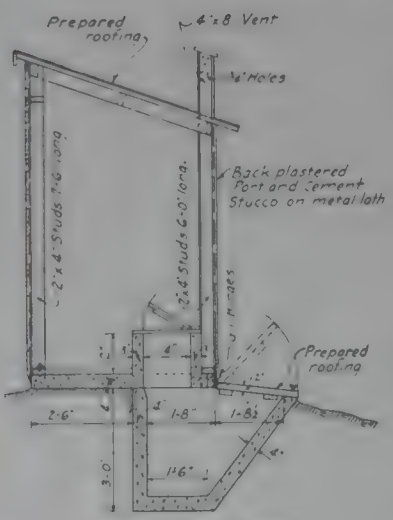
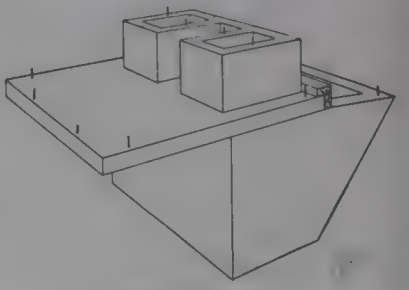


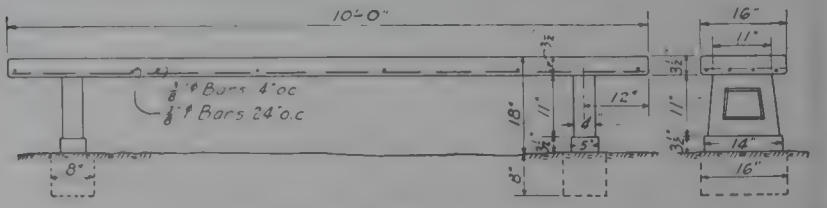
Cement vault prevents disease



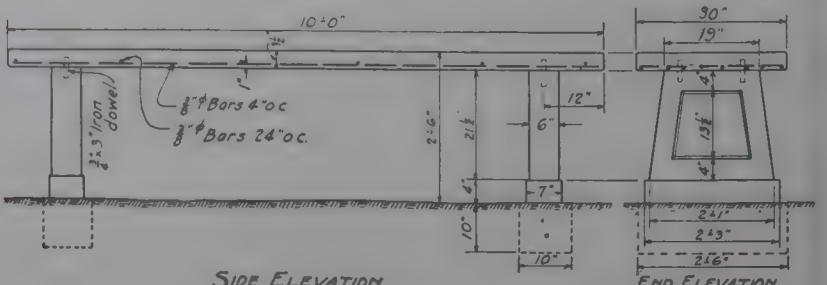
Perspective sketch of vault

They may be conveniently cast on a smooth floor, using dressed 2 x 4's on edge, for forms. The latter must be sufficiently braced, of course, to prevent spreading. Paper laid on the floor will do away with any possibility of the concrete sticking to the floor. The tables and benches should preferably rest on small cement footings to prevent them from settling.

If water is obtained from a well or spring, care should be taken to protect the source of



SIDE ELEVATION — END ELEVATION



SIDE ELEVATION — END ELEVATION

Designs for table and benches suitable for camp or picnic grounds

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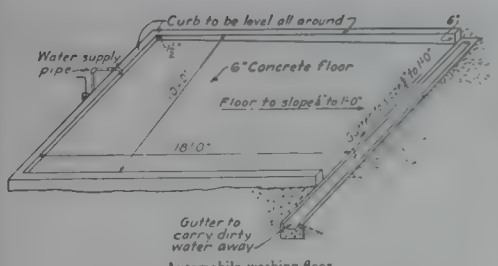


Automobile washing floor

supply from pollution. Cement well curbing and pump platform may be built as shown in the accompanying sketches, the most convenient method of lining the well being by sinking cement pipe.

In describing forms for making a cement well lining in place the National Builder says:

"The forms are usually made of long thin narrow boards attached to wooden discs resembling barrel heads. These discs are commonly 24 inches apart, each disc having a diameter one-half inch less than that of the one above, to prevent binding when the form is removed. The surface of the form must be smooth and well oiled."

The pump platform is made like a sidewalk slab, always being provided with drain board and gutter.

Where sewer connection is not available, the vault shown in accompanying drawings, recommended by the U. S. Public Health Service, may be used. The form work is simple but must be made so that it may be easily taken apart for removal. Bolts are embedded at various points for attaching the superstructure.

A cement cook stove is easy to build and will not need repair. In a large camp several stoves may be made and connected with the same chimney—preferably of cement chimney block. Materials for metal grates and tops are procurable at hardware store or tin shop.

A cement washing platform makes it possible for the camper to remove the dust and dirt of the road from his vehicle and affords a place where he may make minor repairs if necessary.

Cement Dams

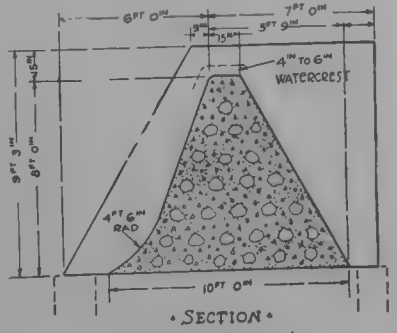
A small dam on many a farm would help to form a pond from which the home supply of ice might be harvested. Then too, such ponds may be used for fishing, swimming, rowing, etc. The design of such structures depends much upon conditions at the actual site of the work.

Dams must be heavy enough and sufficiently anchored to oppose a force of water standing against them, to prevent being moved from their foundations or from being toppled over. A dam must be so designed that the flow of water over the crest will, when falling down the face strike in such a way as to be at once directed downstream. This is accomplished by shaping the face to a curve that deflects the water into the stream bed, or by building an apron on the lower part of the dam to prevent the falling water from pounding at the base and weakening or undermining the foundation.

Sometimes dams are destroyed by the freezing of impounded water and unless exceptionally massive construction is used, reinforcing is necessary to prevent injury from the stresses caused by the expansion when ice forms in the pond.

In the best types of construction, the upper face of the dam is battered, that is, sloped so that the ice will rise when forming and thus relieve the dam from the pressure of expansion.

In most cases the home worker will find it inadvisable to attempt the planning and construction of a dam. Some competent



Section of small cement dam

One good style of construction.

engineer should determine foundation conditions and requirements and suggest or design ways and means of anchoring the dam.

Rollers of Cement

Rollers were originally made from logs of wood. These were abandoned for the more expensive iron rollers. Today these are being largely replaced by cement rollers.

A cement roller is practically indestructible and will never have to be replaced. It will not rust or rot, and is always ready for use.

Obtain a length of sewer pipe, of the size of roller desired. A tile from 12 to 24 inches in diameter will usually suit the purpose. Set this tile on end, small end down, on a wooden platform. Through a hole bored in the platform insert a 1-inch round iron bar, long enough to project beyond the ends of the roller a sufficient distance to provide bearings and attachment for the handles. Care should be taken to get the bar exactly in the center of the tile before placing concrete, and to keep it there while the concrete is being placed. Make a wet mixture of concrete and fill the tile with this mixture, up to the "bell" of the tile. Allow the concrete to set for ten days, when the roller may be placed on side, and the bell of pipe chipped off with a cold chisel and hammer. Attach a forked handle as shown in the illustration. As the axle is a firmly-fixed part of the roller, the fork ends of the handle must be provided with holes, within which the axle can turn.

Cement lawn rollers are easily made

A roller 18 inches in diameter and 2 feet long will weigh about 600 pounds. If a lighter roller is desired, use a smaller sized sewer pipe; or place several small pipes inside the large one, depositing the concrete around them on the outside. They will form hollow spaces inside the roller and lessen its weight.

By increasing the size of pipe, or by using a steel mold and attaching a pair of shafts or a tongue instead of a handle, horse rollers may be made for crushing the clods in the ploughed fields.

Put idle sand and pebbles to work. Bind them together with ALPHA CEMENT into indestructible yard and farm improvements.

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Culverts and Small Bridges

Culverts or bridges of various size are necessary where highways must cross streams in order to take care of only the natural flow of streams, and to provide for flood periods in so far as possible. There is also often a demand for small bridges or culverts on farms where provision must be made to drive team or truck from one field to another where the two are separated by a stream.

The simplest form of cement culvert is that made of pre-cast cement pipe. Such a waterway opening is adapted to all opening requirements from 12 inches up to the largest size of pipe made, providing other conditions would permit the use of this type of waterway opening. Common practice limits the minimum size of waterway openings to 12 inches because smaller sizes so easily become choked with refuse or rubbish carried by the stream.

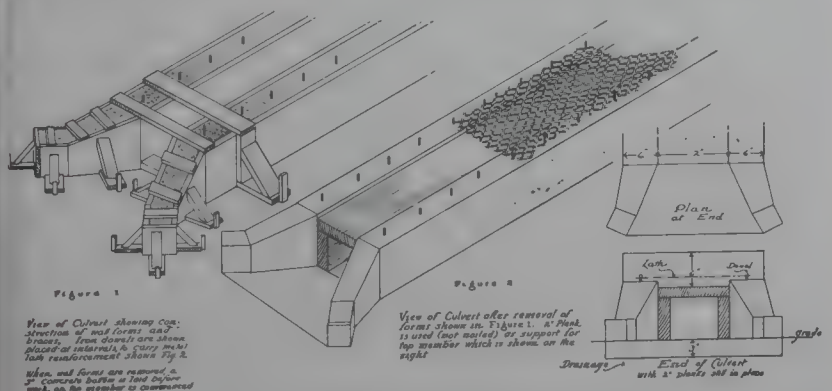
Next to the pipe culvert comes the box culvert. This is very simple to build because no complicated forms are needed and the cement work itself is simple. It is merely a long box or trough with cement sides, top and bottom and open ends or a small cement bridge in which the top slab acts as a floor to support the loads of traffic. The slab must be reinforced with steel rods or heavy steel mesh. Every box culvert should have a cement floor at the bottom to prevent damage to the entire structure from undermining by stream flow.

Cement culverts may be made square or round

There are also culverts of the arch type in which the top is in the form of an arch instead of flat slab. There is no advantage in the arch culvert for small spans unless it is that the small arch requires no reinforcing because the concrete is placed in such shape as to take care of all load put upon it as compression. Naturally it is a little more difficult to build forms for arches than for box culverts.

When cement pipes are being laid for culverts, a carefully prepared trench should be dug, properly curved at the bottom so that pipe may be everywhere embedded at the required level.

Wing walls are usually provided on bridges and culverts to retain the road fill and protect it against stream erosion. A culvert or bridge should, if possible, be in-



Methods of building another good style of square opening culvert

A screen will prevent rubbish filling a culvert or perchance its selection by some animal as a permanent home

stalled at right angles with the road so as to make wing walls straight and parallel with the road. A vertical cut-off wall should be placed at each end of the floor in a box culvert extending down two feet into stream bed below the upper level of the floor as added precaution against undermining. In building small culverts the floor is usually made continuous with the walls and thus acts as a foundation. All culverts should have at least two feet of fill over them to help distribute traffic loads, unless, of course, the highway is paved with cement, in which case the top slab of the bridge or culvert is occasionally designed as a continuation of the highway pavement.

Many of the foregoing statements apply fundamentally to bridges. The term "bridge" is usually applied to a structure larger than one commonly called a culvert. Since every location requiring a bridge involves some different conditions than every other location, it is not possible to standardize bridge designs except within narrow limits of dimension. In other words, bridges that do not need to be more than 16, 18 or 20-foot span can be fairly well standardized so that almost any design for a small structure of this kind can be adapted to practically any location with but minor changes.

The flat slab bridge is probably the simplest form and is particularly suited to the short spans and loads of ordinary highway traffic. It is merely a cement slab of proper thickness, suitably reinforced and resting on abutments. Form work is simple.

Most highway departments have developed standard designs for small culverts and small bridges. From such designs one suitable for the bridge or culvert requirements of any location can usually be selected.

A very important precaution to take in connection with bridge construction is that forms shall be left in place until there is no doubt that the concrete has acquired the strength necessary to support the loads to which the bridge will be subjected when put in service.

Facts About Cement Roads, Streets and Alleys

At the present time the construction of cement pavements for roads, streets and alleys, is progressing at the rate of about 10,000 miles a year. Considering the fact that there are over two and one-half million miles of all kinds of roads in the United States, these figures may not seem very impressive. They have more importance,

Cement pool for water-lilies

ALPHA CEMENT — HOW TO USE IT

however, when one realizes that prior to 1920 the total of all cement roads in the United States built since the first road of that type was laid, amounted to only [illegible] miles. Also, it is only within the past two years that the building of really permanent roads has received its impetus.

The word pavement must be taken in its true sense and not confounded with the commonly used expression "hard surface." There are many types of hard surfaced roads, gravel, macadam and a variety of patented types, depending upon bituminous materials as a binder, etc. Most of these types have proved wholly inadequate to meet the demands of the changing traffic of recent years. The horse, which means the horse drawn vehicle, has all but disappeared from our more thickly settled communities. Even the farmer keeps the horse mostly on the farm and makes his trip to town by automobile or motor truck. It is these vehicles that have transformed highway traffic and hence compelled new standards of highway construction. Wherever it has been used, and that means in all states of the Union, cement pavement is recognized as possessing more desirable qualities than are found combined in any other paving material. In spite of [illegible] the maintaining body [illegible] by all [illegible] cement [illegible] other types [illegible] cost [illegible] the [illegible] cement road has proved [illegible] expensive. Construction costs [illegible] have risen in cost also, but concrete still in the same relative position with respect to its ultimate cost. In fact it has often been proved within the last year or so that even in first cost cement pavements can compete [illegible] of recognized less durability.

A cement road is nothing more nor less than an extension of cement [illegible] designed to embody the qualities that will take care of the different requirements of vehicle traffic as compared with pedestrian

Contractor R. H. Gumz
Eighth Avenue Road, Milwaukee Co., Wis. ALPHA CEMENT used exclusively

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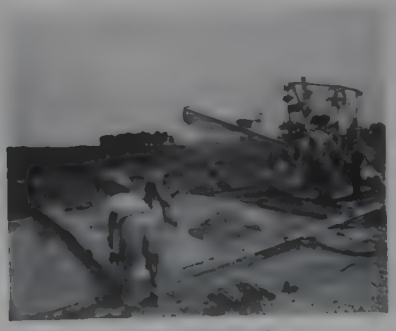

Laying a cement road

traffic. Cement roads are thicker than sidewalks, are usually reinforced, should be built from 18 to 20 feet or more in width, depending upon the volume of traffic to be provided for, should be laid with particular care to the most highly developed drainage of the subgrade possible, and particular care should be given to selection of materials, proportioning, mixing, placing, finishing and curing the concrete. It is not possible with any other type of construction to produce a road surface having the even, gritty surface texture and permanence that result from the use of concrete laid according to the Standard Specifications for Cement Road, Street and Alley Construction.

Just as cement possesses superior qualities as a road paving material, so does it display the advantages of these qualities in street and alley paving. It is comparatively low in first cost, clean in appearance, dustless, maintained at a trifling expense, and the safest for travel in all kinds of weather. It is not affected by the extremes of heat or cold. The surface is so dense and impervious that cement pavements require but little crown to insure quick drainage. Therefore, all of the paved area may be used by vehicles with equal safety. Nothing has to stand harder wear than roads. Cement construction has all the qualities that resist wear and hard usage. That is why the cement road is increasing more rapidly than any other type of pavement.

A community advertises itself effectively (well or ill) by its roads.

Contractor, Wm. Bleichert

76-foot ALPHA CEMENT street, Vineland, N. J.

ALPHA CEMENT — HOW TO USE IT

An improvement that stands year after year

Cement in Land Drainage

Millions of acres of untilled land can be brought into profitable cultivation and the yield from additional millions can be greatly increased by systematic drainage. In this work cement plays an important part, for cement drain tile are considered today as the high quality product in this field. Cement tile are always straight and true to shape, thereby insuring a much greater capacity than misshapen tile which match poorly with adjoining sections, increasing line friction and cutting down the effective area of the line.

One marked characteristic of cement tile is their ability to resist frost action or alternate freezing and thawing conditions. There are numerous examples of cement pipe and tile drains in use 50 years or more and which so far as the cement itself is concerned are still in perfect condition, giving evidence that cement pipe and tile possess in the highest degree the durability necessary to such a permanent improvement as land drainage.

Occasionally one hears that cement pipe or tile will not withstand the action of alkali or certain soil acids. It is true that cement tile have been found almost completely disintegrated, but the causes have usually been quickly ascertained as due to the use of too little cement in the mixture, too dry a mix, unsuitable aggregates or failure to properly cure the product after removal from the mold. Today the products of every reputable manufacturer of cement drain tile may be depended on to meet the standards of the American Concrete Pipe Association.

Contrary to the mistaken belief of many users, tile to be of good quality must be dense and have low absorption. Water enters the line through the small openings left between tile and never properly through the walls of the tile themselves. Before undertaking to lay tile the inexperienced operator should consult his state agricultural college, in addition to securing "Concrete Tile for Land Drainage" (free) by the Portland Cement Association and the comprehensive bulletin on "Land Drainage" by the U. S. Department of Agriculture, Washington, D. C.

The manufacture of cement drain tile is not recommended to the home worker in concrete. It is a process requiring especially skillful treatment and the employment of expensive factory methods beyond the economical reach of the private user.

To Prevent Soil Erosion

Cement walls are often very useful in preventing soil erosion, thereby protecting fertile acres from becoming unproductive. A low retaining wall, carefully buttressed to withstand soil and water pressure, and provided with one or more openings or a spillway to take the run-off, is usually all that is required. The wall must be started below frost penetration, on firm soil. Wing walls and buttresses are frequently required for stability and reinforcing is customarily employed.

The agricultural engineering departments of practically all agricultural colleges are prepared to consult with farmers relative to erosion problems and to provide them with precise information and plans based on the necessities of each individual situation. In general these walls are built in the same manner as light dams.

Dampness helps rather than harms concrete

Thirty-inch cement sewer pipe. Cement pipes are characterized by smooth interiors and trueness to shape, prime essentials for first class sewer work

Cement Sewers and Cement Sewer Pipe

Probably no municipal work calls for better or more durable construction than a sewerage system. It is for that reason that concrete, both in the form of monolithic construction and cement pipe, is used so extensively in sewer work. Concrete and cement pipe are designed to meet normal and abnormal structural conditions. In the larger sewers where structural strength is of very great importance, there is no material or combination of materials comparable with reinforced cement pipe and reinforced monolithic concrete.

Over 75 per cent of sewers above 30 inches, built during the past decade in the United States and Canada are concrete, either reinforced pipe or monolithic concrete. Since contractors have equipped themselves to handle large units, reinforced cement pipe is used almost exclusively in sewers between 27 and 108 inches internal diameter. New York City has an investment of over $30,000,000.00 in cement sewers. The Sanitary District of Chicago, which uses monolithic concrete construction exclusively, has an investment of over $20,000,000.00 in cement sewers. Detroit has over $16,500,000.00; Kansas City, over $5,400,000.00; Seattle, over $3,400,000.00; St. Louis, over $3,000,000.00, or a total of $78,300,000.00 for the six cities listed. A conservative estimate of expenditures for cement sewers in cities of the United States is over $250,000,000.00. The values of sewage disposal plants which are built exclusively of concrete in the United States is more than $80,000,000.00. The combined total is $330,000,000.00.

Cement sewers have the greatest hydraulic capacity of any type. Bulletin 852 entitled "The Flow of Water in Concrete Pipe," published by the U. S. Department of Agriculture in 1920, features the great hydraulic capacity of cement pipe. Based on the coefficients recommended for various classes of construction, cement sewers will discharge over 25 per cent more sewage for any given diameter, irrespective of gradient, compared with other competing types.

Cement pipe is made in true circular form and under the American Society for Testing Materials specifications for plain cement pipe 24 inches and under, a smaller permissible variation from roundness is permissible than for other types. With the adoption of these standard specifications it has been the common practice to test cement pipe. Such tests show uniform quality, high strength, density and impermeability to water.

Cement in Irrigation

Those of us who are in the habit of living where rainfall is frequent and ample for all crops usually grown, can hardly appreciate the money value which water has in many sections of the arid west. In those sections, water is really a marketable commodity, and millions of dollars have been expended in building huge storage reservoirs of which cement dams are a feature, merely for the purpose of conserving water so it may be distributed where and when most needed for irrigation. Many of the so-called reclamation projects which have been carried on by the U. S. Government have made available for agricultural pursuits millions of acres of land saturated with fertility but which could not contribute that fertility to agriculture because of limited or no rainfall in the part of the country in question.

With such a value placed upon water in these arid and semi-arid sections, every means is used to conserve local resources, and in that conservation cement has long played an important part. The loss of water through seepage in earth canals is very great. Wood linings were used at one time quite largely to prevent these seepage losses but timber was expensive and short lived and for this reason proved inefficient because involving high cost of maintenance. Now, no irrigation project is planned or put

Cement linings for irrigation canals reduce water wastage to a minimum and increase the speed of flow

into operation without making extensive use of concrete to line main canals and laterals. In some cases underground cement pipe lines operate in place of open ditches. Even though the flow area of ditches is lined with concrete, there is nevertheless often considerable evaporation of water in transit. Where such losses are great, it is desirable to prevent them as well as seepage losses.

The Portland Cement Association has published booklets entitled "Concrete for Irrigation Canals" and "Concrete Pipe for Irrigation" which set forth at greater length the various advantages of concrete in this field of use and the many pictures in these booklets illustrate how extensive that use has been. Certain details of construction are shown and methods of construction described. We shall be glad to send copies of these booklets to anyone interested.

Cement in Mines

Cement has long been used extensively in mine workings both above and below ground. In any mining operations, underground fire particularly is always to be dreaded. Liability of fire is greater in some classes of mines than others, notably in coal mines, but in any event precautions must be taken against fire because of the probable loss of life that would follow the burning of underground structures. The word "structures" in this sense is used to refer to mine props, shaft linings and hoisting stations or any other workings where timber has been and formerly was the material most used to keep the portions of the mine being worked from caving or falling in.

In most mines the conditions of the atmosphere with particular reference to dampness are ideal for the rapid rotting of timber. At one time timber was preferred as a material for all underground as well as above ground structural purposes in mining operations. There was a logical reason for this since in most mining sections in the early days the surrounding country was well covered with timber. Therefore such material was right at hand and cost practically nothing. However, its short life in use made the maintenance high, and in the end timbering proved most expensive. Many disastrous fires also pointed to the wisdom of preventing a recurrence. The result was a gradual turning to cement which in recent years has been followed by most wonderful development of the use of cement in mines. Shafts are now completely concrete lined, underground timbering is all of concrete, tunnels are lined either with monolithic concrete or by a layer of concrete of varying thickness applied by means of a cement gun or similar apparatus, and all structures above and below ground on a mining property that promises long time operation are made permanent, maintenance free and proof against fire by exclusive use of concrete.

"Concrete in Coal Mine Structures" is the title of a book published by the Portland Cement Association, which illustrates the wide use of cement in this industry. A copy of this book will be sent on request.

Cement distributing gate from which the water reaches the lateral lines in the fields and orchards

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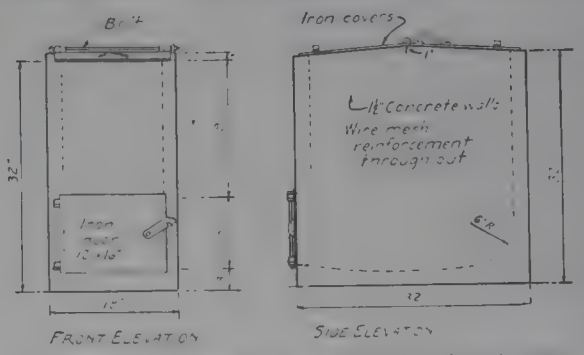

Fig. 1. Design for a cement garbage container which should have a large sale in every city. The cement box is sanitary and indestructible and will last a lifetime

Salable Garbage Box

Most garbage boxes have been made of wood or galvanized sheet iron—both materials short lived and otherwise poorly adapted for the purpose. Wooden boxes harbor rats and soon become decayed, odor-infested and rickety; metal boxes become battered out of shape, rust out, develop sharp edges and allow filthy liquids to leak out. A well made cement box is superior to all others because it is good looking, permanent and odor-proof, and can be burned out or otherwise disinfected if ever required.

The receptacle shown in accompanying drawings is 18 inches wide, 24 inches long and 32 inches high, outside measurements. The side walls are 1½ inches thick and the bottom has a minimum thickness of two inches. The thickness of the bottom at the opening in the back of the box is three inches, the floor being rounded in order to retain liquids and smoothed to facilitate cleaning.

Boxes of this size containing a free space volume of about 7¼ cubic feet are ordinarily rated at 55 gallons capacity and are large enough to take the pure garbage from any private residence or from at least four ordinary city apartments where collections are made regularly. The doors are made of 14-gauge or 16-gauge galvanized steel plate attached by means of bolts and straps embedded in the concrete. The back door has a catch easily opened and fastened with the collector's shovel.

This box is perhaps most easily molded in an upright position as it appears when in use. The outer form should be made in four pieces of heavy sheet steel, at least 10 or 12 gauge. These should be riveted to angle iron or attached by screws to 2 by 4 ribs and designed so that all four sections can be rigidly and tightly joined together. The inner form is made in two sections, the larger section taking care of all of the inner surfaces except the opening for the clean-out door. This larger section is made of sheet iron on a wooden frame which collapses in two directions and has a slight taper in the other two directions. The smaller section of form which provides for the clean-out opening is made of wood covered with sheet steel and is dowelled by means of two small steel pegs, to the larger section. This smaller section is withdrawn first through an opening in the outside form. The larger section of the inner form is then carefully withdrawn vertically by means of a chain hoist and the outer forms then removed. The surface is immediately patched, painted with a cement wash and cured for at least two weeks.

Reinforcing for these boxes usually consists of a basket or heavy ¼-inch mesh galvanized steel wire of either square or triangular shape.

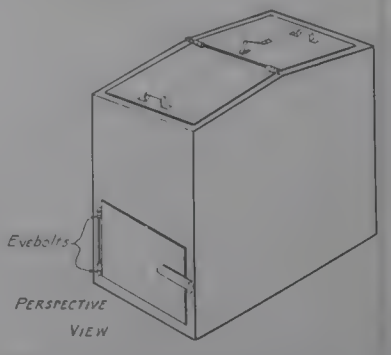

Fig. 2 Perspective of the box shown in Fig. 1 showing the sheet steel doors and methods of attaching

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Ready-Mixed Concrete

In recent years the marketing of ready-mixed concrete has developed rapidly. Central mixing plants designed to furnish a single job were used several years ago. Results, however were not generally satisfactory due to the fact that segregation of the concrete materials in transit produced structures of questionable quality. Recent development of truck bodies designed for transportation of concrete has eliminated segregation so that with special equipment the quality of the concrete is not impaired.

There are two generally approved methods of making ready-mixed concrete:

1. A batching plant for proportioning dry the cement, sand and coarse aggregate. The dry mix is chuted into specially designed trucks which add water and mix the concrete while traveling to the job.

2. A central batching and mixing plant, with special trucks designed to prevent segregation, for transportation of the concrete to the job.

Architects, engineers, contractors and other users of concrete are requiring quality concrete. Where the builder does not want to install his own mixing equipment on the job, he specifies the quality of ready-mix concrete required. The advantages which appeal to the user of ready-mixed concrete are:

The approved types of ready-mixed concrete plants assume the responsibility for proportioning and mixing all concrete as specified, certifying to the proportions furnished. This usually results in greater uniformity than is obtained by mixing the concrete on the job. The equipment of the ready-mixed concrete manufacturer measures accurately the quantities of cement, sand, coarse aggregate and water, thereby controlling the quality of the concrete. The user does not have to set up and maintain a concreting plant, provide storage facilities for cement and aggregates and arrange for the necessary supply of water. Often such storage space and water supply are difficult to provide in congested business districts and are unsightly in residential areas. At the completion of the job, the hauling away of concreting equipment and excess materials is eliminated.

With ready-mixed concrete, the user can specify the proportions of cement, sand, coarse aggregates and water to be used or can ask for concrete of predetermined strength. Sand and aggregates are usually tested for moisture so that not more than the proper amount of water is used. During cold weather, the user may obtain ready-mixed concrete delivered on the job at a specified temperature thus reducing the possibility of damage due to freezing.

Airports

The day of the "flying field" is definitely past. If the great, modern air transports are to operate safely and efficiently, they must be provided with ports as modern as the planes themselves.

In aprons, runways and taxiways at airports there are more than one million square yards of concrete pavements. The airplane has been relatively quicker in sensing the value of concrete than the motor car was. It is asking too much to force an expensive plane, loaded with passengers, to take off or land on turf that inevitably develops ruts, becomes soggy, uneven and tricky. Concrete pavement is the answer.

Either plain or reinforced concrete is used in paving the aprons and runways. Concrete affords low maintenance costs, good visibility, a skidless and dustless surface of assured long life. The time-proven durability of our modern concrete highways recommend this type of paving to the designers of airports.

The layout of runways is a much discussed matter but the indications are that the ideal arrangement will include a double system, permitting planes to land and take off simultaneously without danger of collision.

Hangars today are of great span, firesafe and, almost invariably, floored with concrete. They open out on concrete aprons, which connect with the landing zone and the runways by means of concrete-paved taxiways.

The modern airport is incomplete without an administration building, which should be an attractive, firesafe structure equipped to take care of the comfort and convenience of all who come to the airport. There is no airport structure which is not, or cannot be best constructed with concrete.

The use of concrete in airports does not end with pavements and floors but includes structural concrete, stucco, concrete blocks and other cement products.

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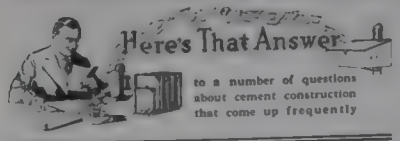


How can concrete be made to knit together firmly when the work is done at different times?

It is always best to arrange to have the surface or finishing coat of concrete placed before the other concrete has fully set; then there will be no trouble about getting a good bond. However, when it is necessary that a facing or extra coat of concrete be added, after the completion of the other work, the surface on the old concrete should be thoroughly cleaned, using for this purpose a solution of one part muriatic acid to three or four of water. Let this wash stay on the surface until the concrete has been etched away enough to expose the rough aggregate. In this way, the new concrete will have something on which to get a grip. Before applying the fresh concrete, flush off the rough surface of the old concrete with clean water so as to remove the acid thoroughly and keep the surface thoroughly wet until the new concrete is applied. For such work, a mix of one part cement and two of sand will give the best results.

Often, when I am trying to get a nice, smooth walk, I find that pockets have been left in the concrete, and this makes the surface look unsightly when the forms are taken away. How can this be remedied?

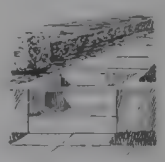
The best way to remedy this fault is while the concrete is being placed. In the first place, the mixture should be mushy enough to pack down solidly and care should be taken to see that the larger stone used in the work is mixed well up with the smaller. But even when this is done, it is best at frequent stages of the work, to take a spade or other flat tool, and work this down between the fresh concrete and the outer form. This will shove the larger stone away from the extreme edge and permit the fine material to work outward. On thin vertical sections this may also be corrected by vibrating the side forms by tapping with a hammer as the concrete is placed.

What is the best way of preventing cracks in pavements and driveways?

Probably ninety per cent of all cracks in pavements and driveways are caused by the action of frost. The remedy is a deep, well laid and well drained subbase composed of material such as cinders or ashes that will not expand in freezing.

Cracks come frequently from the neglect to provide for expansion and contraction. Concrete that is exposed to heat and cold is subject to a certain amount of contraction and expansion. The expansion joint should not be a mere ornamental line on the surface but should extend down through the slab. Some contractors provide for this by first laying only every other slab. When the first slabs are hard, the empty spaces are filled.

Fine or "hair" cracks are usually caused by too much fine sand or by excessive troweling before the cement has taken its initial set; the troweling brings the cement and fine material to the surface. Give the cement time for the initial set before beginning the final troweling. Hair cracks do not extend deep and do not ruin the walk but mar its appearance.



A few months ago I put a cement cellar wall in a house that I was building at that time. During the last week we have had some heavy rains and the water has leaked in. Is this the fault of the cement or poor mixing?

Your concrete was probably lacking in density.

Numerous tests by various scientific bodies as well as by the Bureau of Standards of the U. S. Government have shown that the best way to secure a waterproof concrete is so to grade your aggregates

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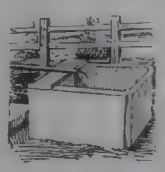
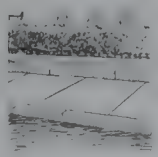
as to secure the densest possible concrete. By this is meant, use stone and sand, the particles of which are varied in size so that the spaces between them when they are mixed together will be a minimum. A concrete made of aggregates graded in this way in which sufficient water is used to make a mushy mass and which, when placed in the forms, is well tamped and spaded, will generally be waterproof, that is, unless the wall is thin. By spading is meant shoving a thin, sharp-edged tool down between the concrete and the forms and also shoving it down into the center of the mass while it is being placed. This forces the larger stones back from the face of the concrete, and allows a mixture of rich grout to come to the exposed surface of the work, and releases bubbles of air in the center of the mass that would otherwise leave hollow spaces. Additional density can be secured by painting the surface of the concrete. (See page 36.)

It is very difficult, where a wall has already been built and found to be porous, to correct the trouble from the inside. It can be done by building an extra 4-inch wall with an open space of from 1 to 1½ inches between that and the old wall and providing a way for the water to flow out from this space into a drain; or by applying pitch and felt and an extra wall or layer of dense concrete, but by this method the floor must be a continuous, dense slab of concrete, otherwise the water will find its way under the floor and come up through that. Correction from the inside is troublesome and costly. It is better to get at the leak from the outside and by the application of tar and felt, a waterproofing compound or by a supplemental wall or mass of dense concrete on the outside, to keep the water away from the porous wall. As a matter of precaution, a drain should also be laid.





What is a simple rule for determining the amount of cement required by a certain proportion?

The following rule is one used by some contractors in getting a quick, general estimate of the cement required: Divide the total of the figures representing the proportions into 11 and use the result as the number of barrels of cement needed for a cubic yard of concrete. To illustrate. The proportions are 1:3:6; the total of 10 divided into 11 gives 1 1-10 as the number of barrels of cement required for each cubic yard of the volume to be filled. This rule gives approximately correct results.

During September, when we had some very cool nights, some concrete that I had in forms looked as if it were not going to set at all. I complained about the cement but let the forms stay and a week later the concrete was as hard as a rock. Can you explain this? I am sure the concrete did not freeze much, if any.

The following extract from the *Engineering News* answers this question well:

"The fact is that while most constructors realize that concrete will not set in freezing weather, many do not appreciate that from 45° F. down to freezing there is a definite slowing up of the setting, which is actually more dangerous than a complete failure to set. Anyone ought to be able to recognize a frozen concrete; it takes a much higher degree of skill to determine a working-strength set.

'During the later fall, in most parts of this country, night temperatures will be hovering around freezing, although in the daytime artificial heating of the concrete will rarely be required. In consequence, much concrete from which normally the centers could be removed in two or three weeks, will be so retarded in

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set as to be dangerously near failure, unless supported for a week or two weeks beyond the standard period. If the discouraging records of all the autumns of the last ten years are not to be repeated, every man responsible for the laying of reinforced concrete will study his thermometer during October and November and be quick to protect his forms when the temperature gets into the forties."

FIG. 1 FIG. 2 FIG. 3

I intend to put a cement floor in a small power house in which will be installed a gasoline engine that will be used for pumping, running cream separator, etc. How can I lay the floor so as to provide for bolting the engine down firmly?

There are two ways of doing this: one is to anchor pieces of hard wood, say 4 in. x 4 in. timber in your concrete in the manner shown in Fig. 1, where the timber is set flush with the floor and is countersunk for a nut and washer.

The other would be to set the anchor bolts in the concrete permanently (see Fig. 2). This can be done by making a wooden template of the base of the engine (a frame that will accurately locate all bolts and suspend them in position); place this template in the position desired and fix the anchor bolts in the template at a proper distance above the floor.

If the cement floor is already laid and you desire to anchor a gasoline engine to it, holes can be drilled in the concrete, as illustrated by Fig. 3, and anchor bolts securely fastened by lead, melted sulphur, or a rich cement grout. These holes can be drilled with an ordinary hand drill such as is used for drilling rock. Be sure the holes are drilled deep enough to give you a secure fastening for the engine, then place the bolts in the holes so that they extend at a proper distance above the floor, and pour lead, melted sulphur or rich grout ("soupy" cement mixture) around them.

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Ice House
Manure Pit
Septic Tank
Oil Storage Tank
Water Tanks
Tennis Court
Inclosure Walls
Retaining Walls
Barn and Silo
High Early Strength Concrete
Corn Crib
Poultry House
Smoke House
Hog House
Dipping Vat
Piers for Small Boats
Garden Furniture
Sewer Pipe and Drain Tile
Bulk Cement
Hotbed
Greenhouse
Coal Pocket
Fence Posts
Swimming Pool
Concrete Floors
Garages and Runways
Cement Stucco
Cold Weather Concreting
Warm Weather Concreting
Watering Trough

Name.....

Address.....

Get the ALPHA BUILDING HELPS

ALPHA SERVICE SHEETS and LITERATURE now available on the subjects named on these mailing cards. In issuing literature it is not our desire to supplant the architect or the contractor, but rather to supply fundamental information that will be helpful in suggesting new, better and more lasting ways of building.

CARD No. 1

If you have not already received ALPHA BUILDING HELPS relating to the improvements you are now planning, ask your dealer for them—or, if you prefer, check the subjects which interest you on Card No. 1, sign your name and address and mail it to us at once. We will send you, postpaid, the information asked for.

CARD No. 2

If you have a neighbor who is thinking of building anything named on the list below, hand him Card No. 2. With it he can send for a free copy of our book "ALPHA CEMENT—How to Use It" and other literature that will help him to build the improvements he contemplates. You surely know of someone who will be glad to get this valuable aid. He will thank you for the hint.

CARD No. 2

HAND THIS CARD TO A NEIGHBOR
IF HE IS PLANNING CEMENT WORK

ALPHA PORTLAND CEMENT CO.
Easton, Penna.

This card was given to me by.....

I am planning to build.....

Please send me a copy of the book "ALPHA CEMENT—How to Use It" and the ALPHA Building Suggestions showing how to construct the improvements I have checked below:

Homes
Sidewalks
Cement Roads
Bridges and Culverts
Basements and Foundations
Gutter and Curb
Storage Cellar
Small Warehouses
Spring House
Cement Blocks
Porch and Steps
Small Dam
Milk House
Ice House
Manure Pit
Septic Tank
Oil Storage Tank
Water Tanks
Tennis Court
Inclosure Walls
Retaining Walls
Barn and Silo
High Early Strength Concrete
Corn Crib
Poultry House
Smoke House
Hog House
Dipping Vat
Piers for Small Boats
Garden Furniture
Sewer Pipe and Drain Tile
Bulk Cement
Hotbed
Greenhouse
Coal Pocket
Fence Posts
Swimming Pool
Concrete Floors
Garages and Runways
Cement Stucco
Cold Weather Concreting
Warm Weather Concreting
Watering Trough

Name.....

Address.....

MAILING CARD

Place Required Postage Here

ALPHA PORTLAND CEMENT CO.

15 S. Third Street

SERVICE DEPT. Easton, Penna.

MAILING CARD

Place Required Postage Here

ALPHA PORTLAND CEMENT CO.

15 S. Third Street

SERVICE DEPT. Easton, Penna.

Built with ALPHA CEMENT

EXAMPLES of LARGE BUILDINGS of GREAT ENGINEERING UNDERTAKINGS IN WHICH ALPHA CEMENT WAS USED AFTER MEETING SEVERE TESTS FOR HIGH QUALITY

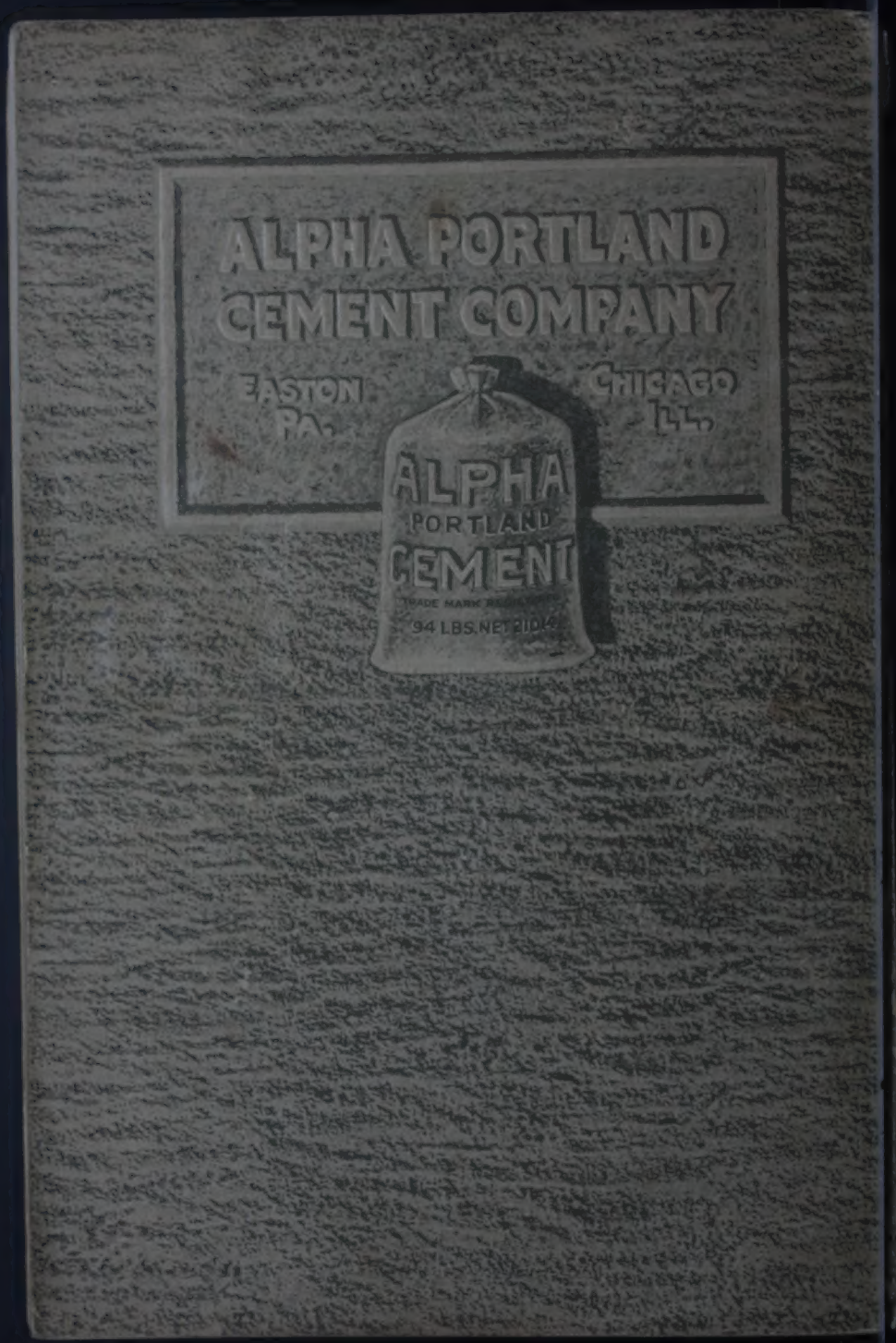
Pennsylvania Station
New York

Detroit River
Tunnel

Cincinnati Ohio Terminal Warehouse
Constructed Winter 1923-1924

Wanamaker Store
Philadelphia

D. L. & W. R. R. Bridge across
Delaware River, Portland, Pa.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CEMENT COMPANY
EASTON
PA.
CHICAGO
ILL.
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PORTLAND
CEMENT
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